Draft 1987 Combined Sewer Overflow Control Plan

METRO

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Clean Water A Sound Investment

<u>DRAFT</u>

1987 CSO CONTROL PLAN

MUNICIPALITY OF METROPOLITAN SEATTLE

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SUMMARY

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SUMMARY

PURPOSE

On July 29, 1986, the Metro Council adopted a plan for secondary treatment and combined sewer overflow (CSO) control. In September 1986, the state Department of Ecology (Ecology) advised Metro that changes in the adopted CSO plan would be required. In January 1987, Ecology published a new regulation regarding CSO control. This regulation contained several requirements necessitating revision of the 1986 CSO plan. It is the purpose of this report to provide the added information, which coupled with earlier CSO reports, will provide an overall CSO control plan meeting Ecology requirements.

SCOPE

The CSO requirements which were presented in earlier planning documents are not repeated. This report describes modifications made to previously-identified CSO projects subsequent to the 1986 report, describes representative Metro CSO projects to achieve Ecology's requirement of a 75 percent CSO volume reduction in the overall service area over the next 20 years, and identifies CSO projects that could be added to this 20-year plan to achieve the ultimate goal of one CSO event per year.

CSO CONTROL PROJECTS FOR 75 PERCENT VOLUME REDUCTION

Some of the CSO control projects evaluated in earlier reports have been modified:

- **University Regulator CSO Control (Green Lake/Interstate-5 Separation)**--Costs have increased as a result of predesign changes made to avoid construction of a pipeline through Ravenna Park.

- **Hanford Separation (now the "Hanford/Bayview/Lander" project)**--During the initial stages of design of the Hanford separation project, the City of Seattle decided to reactivate the abandoned Bayview tunnel. In conjunction with the original Hanford project, combining storage in the tunnel with separation of sewers in the Lander area proved to be a cost-effective CSO project.

- **Denny Way CSO Control**--The 1986 plan included a plant located east of Myrtle Edwards Park to treat CSO. The City of Seattle subsequently initiated the planning of a project to separate sewers in the east Lake Union area upstream of Denny Way. In conjunction with this City project, it was found that partial separation of sewers in the Denny area was more economical than a CSO treatment plant.

- **Parallel Fort Lawton Tunnel**--Subsequent to the 1986 plan, Ecology required that the parallel tunnel, previously included as a CSO project, be an integral part of the secondary plan. Thus, only the incremental costs associated with providing added capacity in the tunnel for CSO control purposes is considered a CSO cost in this report.

The representative projects to achieve 75 percent volume reduction are:

Southern Service Area (SSA)	Northern Service Area (NSA)
CATAD Modifications	CATAD Modifications
Hanford Separation/Bayview Tunnel/Lander Separation	Increase Size of Parallel Fort Lawton Tunnel for CSO Flow
Diagonal Separation	Green Lake/Interstate-5 Separation
Kingdome/Industrial Area Separation	
Michigan Separation	
Denny Separation	

Although several separation projects are involved in this plan, about 86 percent of the existing combined area will remain combined. Each separation project will involve added storm drain discharges. Although only 14 percent of the combined area will be separated, careful evaluation of potential effects from storm drain discharges will be made during the predesign environmental process. If necessary, corrective measures will be identified and implemented on a project-specific basis.

The total capital cost, including Alki and Carkeek CSO projects is $114.5 million (1988 dollars) for 75 percent volume reduction. This is less than the $182 million shown in the 1986 plan for the same volume reduction for several reasons:

- Ecology will now accept 75 percent volume reduction for the overall service area rather than requiring that it be achieved in both the NSA and SSA, permitting a savings of $16,500,000.

- When combined with the City's east Lake Union separation project, Metro's Denny separation project cost is lower in cost than the Denny CSO plant used in the 1986 plan ($29,800,000 savings).

- The cost of the parallel Fort Lawton tunnel for base flows is now considered a secondary cost rather than a CSO cost ($16,100,000 CSO cost reduction).

- The modified Hanford project provides added cost-effective CSO benefits ($11,600,000 savings).

- The Alki equalization/secondary facilities including in the 1986 plan were replaced with a stormweather plant at Alki at a lower cost ($7,700,000 CSO cost reduction).

- Offsetting some of the savings was a $14,200,000 increase in the cost of the Green Lake/Interstate-5 separation project.

Based upon phasing the projects over the next 20 years, the present worth of the CSO projects for 75 percent volume reduction is $96,527,000. The inflated capital cost over the same period is $235,860,000.

Partial separation of about 9,000 acres of currently combined area at a cost of $175,000,000 (1988 dollars) would, when added to the above projects, achieve the ultimate goal of one event a year. Added projects to achieve this goal would not be undertaken until after 2005. In the interim, the effectiveness of the initial Metro projects will be measured, evaluated, and reported on at five-year intervals to determine what adjustments may be needed to achieve this goal.

CHAPTER 1

CHAPTER 1
INTRODUCTION

THE COMBINED SEWER OVERFLOW PROBLEM

Substantial portions of Seattle are served by sewers that convey both sewage and stormwater. Overflows caused by excess stormwater in the combined sewers in the Seattle system affected water quality along the shorelines of lakes Washington and Union, the Ship Canal, the lower Duwamish River, Elliott Bay and Puget Sound beaches in West Seattle and Magnolia. The location, frequency and volume of combined sewer overflows have been greatly reduced in recent years through City of Seattle sewer separation projects and construction of special storage tanks. Metro has also contributed with pumping station upgrades and CATAD, a computer-control system, that regulates flows in the sewerage system to get maximum use of storage capacities in the existing pipes. All CSOs along Lake Washington and West Seattle beaches have been controlled to at least the one-year storm level. Figures 1-1 and 1-2 provide an overall description of the historic and current situation (see 1985 and 1986 plans for related discussion.)

While much progress has been made, overflows persist. In an average rainfall year, nearly 2.4 billion gallons of untreated sewage mixed with stormwater still spill from 21 CSO points in Metro's West Point collection system. Additional overflows occur at a number of City of Seattle CSO points. Of the Metro total, about 460 million gallons overflow into the Ship Canal and Lake Union, while 1.9 billion gallons spill into the lower Duwamish River and Elliott Bay.

PAST STUDIES OF CSO CONTROL

Several studies on CSO control for the Metro system have collected data on the amount and characteristics of overflows, data which has been used in preparing this report. An extensive evaluation of CSO control alternatives is contained in Metro's 1979 *CSO CONTROL PROGRAM REPORT*. This Metro study, done in conjunction with the City of Seattle's CSO planning, evaluated controlling CSOs in a range of rainfall conditions and using a variety of control methods. The Metro plan recommended a combination of storage and treatment facilities. The City and Metro agreed that first priority be given to controlling CSOs into Lake Washington.

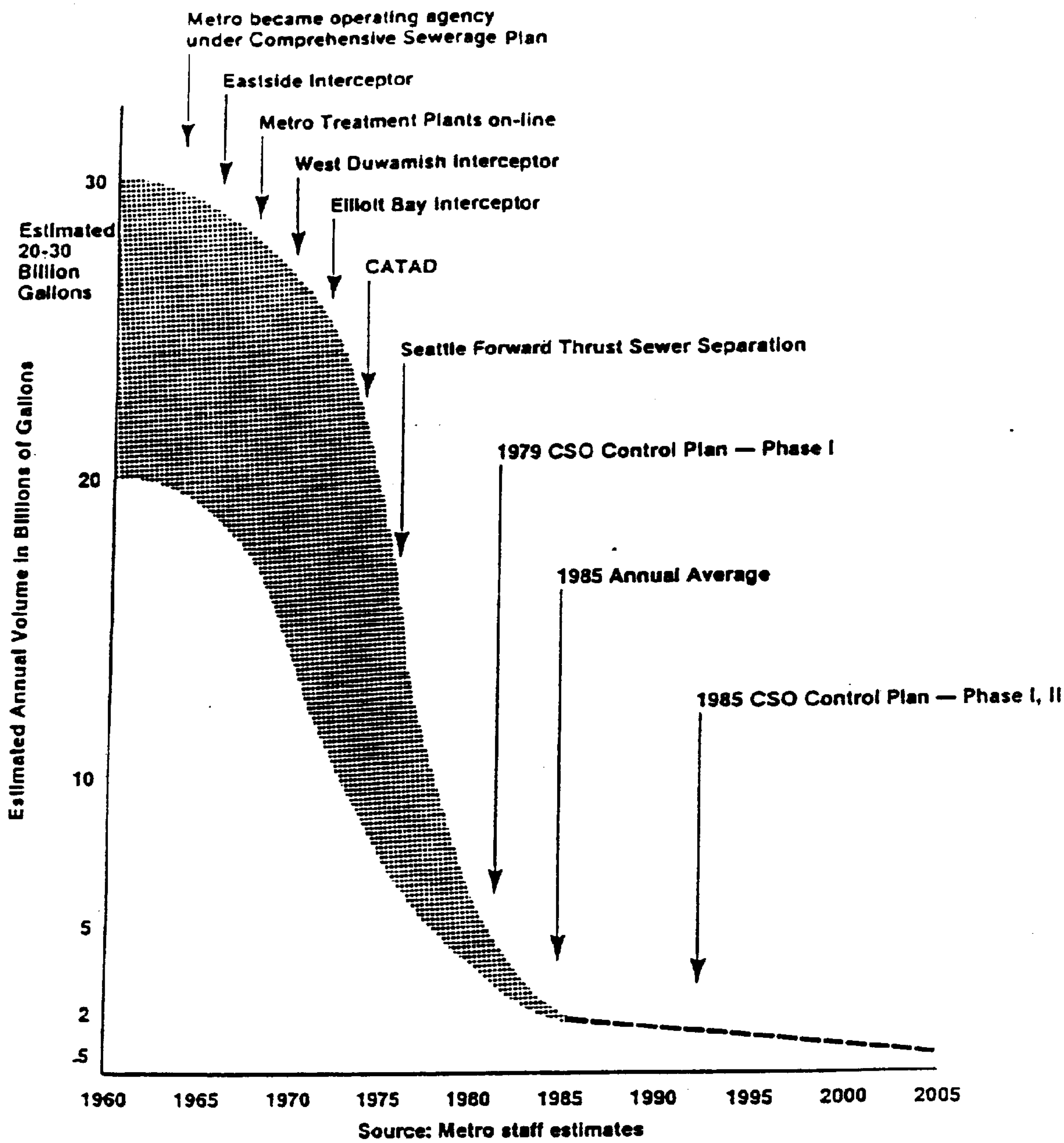


Figure 1-1

Reduction in Untreated Sanitary and Combined Sewer Overflows in the Seattle area since 1960.

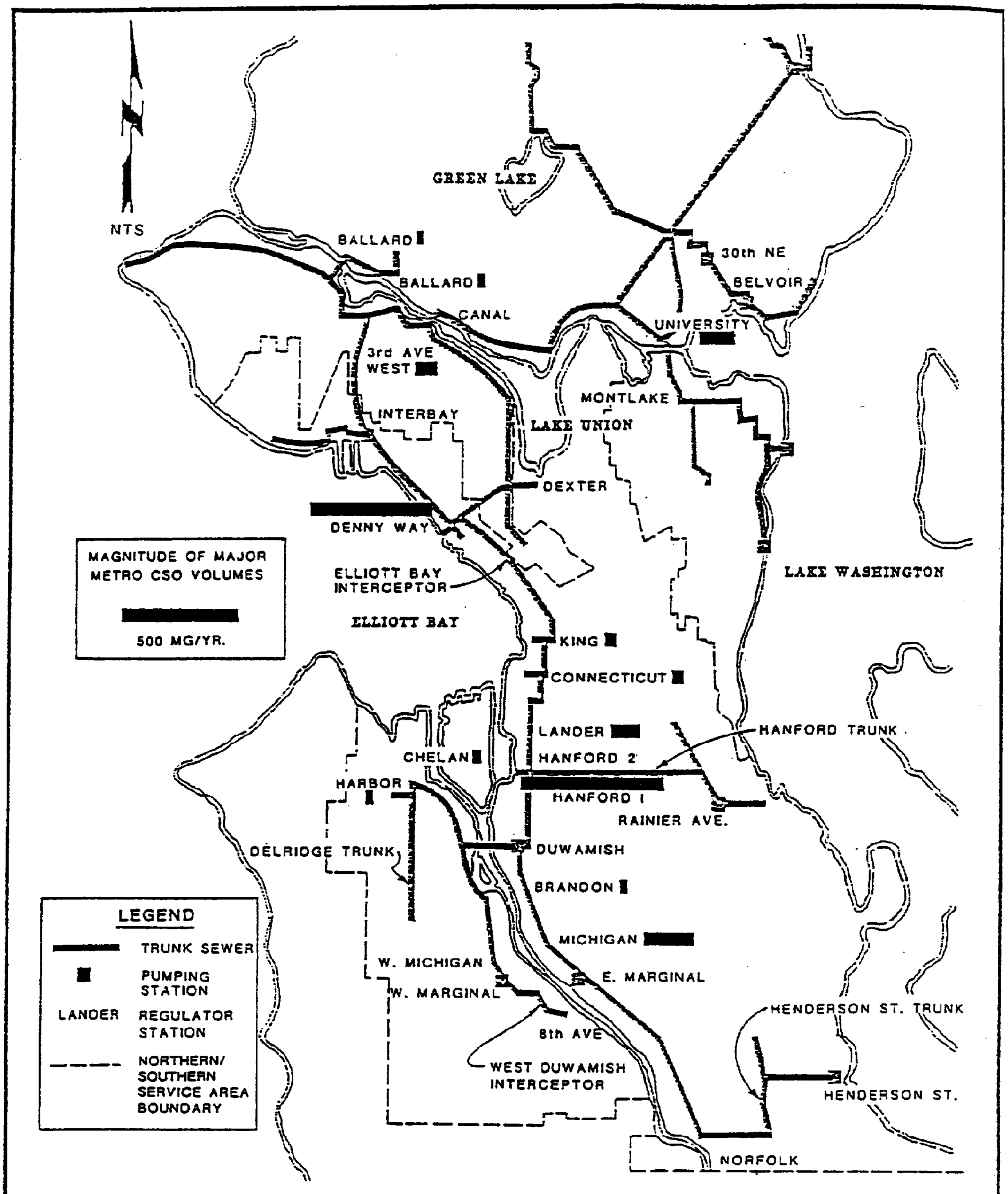


Figure 1-2 CSO LOCATIONS AND VOLUME

Metro's 1979 plan recommended a $71.2 million program (1988 dollars). Most of the top-priority storage projects built by the City of Seattle were specifically aimed at protecting Longfellow Creek and Lake Washington. Under the 1979 plan, Metro has adjusted weirs, modified CATAD operations and upgraded Lake Washington pumping stations. In addition, all of Metro's Alki collection system was upgraded to reduce CSO events to the one-year-storm level.

In addition to its CSO control projects, the City has adopted a drainage ordinance (No. 108080) that will reduce city CSO. A drainage control plan is required for new development greater than 2,000 sq. ft. (proposed to be reduced to 750 sq. ft.) of impervious surface. The plan is for *"collecting, controlling, transporting, and disposing of stormwater falling upon, entering, flowing within, and exiting the property under development."* The ordinance requires that new developments either provide separate storm sewers for drainage, or provide on-site control of stormwater to reduce the peak flows leaving the development. Such measures will reduce CSO.

As part of the planning for secondary treatment facilities in 1985, a further analysis of CSO control alternatives was made and reported in Volume III of the November 1985 secondary facility plan. This report analyzed the effects of four different secondary treatment system configurations on CSO. The report established a reasonable, yet significant level of CSO reduction for both fresh- and saltwater areas and provided a comparable level of CSO reduction for all four system alternatives. All system alternatives with the CSO control projects recommended in the 1985 plan would reduce system-wide overflows over 20 years by 70 to 76 percent, below today's condition. The recommended CSO control costs ranged from $88 million to $129 million (present worth, 1988 dollars), depending upon the secondary system alternative. The recommended level of CSO control was based on the "knee-of-the-curve" concept, where project costs increased most sharply relative to the CSO volume reduction attained.

In 1986, at the request of the City of Seattle, Metro considered additional non-West Point configurations for secondary treatment and issued a supplemental facility plan, including a supplemental CSO control plan. In addition to evaluating the CSO projects at a redefined knee-of-the-curve level of control, Metro evaluated projects to achieve 75 and 90 percent volume reduction for all secondary system configurations. In addition to the CSO control projects identified in the November 1985 plan, Metro evaluated several additional projects and modified some of the CSO projects described in the 1985 plan based on technical refinements to the earlier work. The agency also improved and updated computer models used to analyze CSO options and estimate pollutant loadings for the 1986 analysis. The NSA CSO projects were re-evaluated using updated basin characteristic data and the revised models. The present-worth costs for CSO control projects phased over a 20-year period ranged from $61 million to $90 million at the knee-of-the-curve, $104 million to $157 million at 75 percent CSO volume reduction and $188 million to $256 million at 90 percent CSO volume reduction.

In the 1986 CSO plan, the knee-of-the-curve level of control was redefined as the point where the first break in the cost-benefit occurred rather than where the sharpest break occurred. The knee-of-the-curve level of control for the Core 4 secondary plan, for example, was 61 percent in the 1986 plan versus 74 percent in the 1985 plan. As a result, the knee-of-the-curve costs decreased relative to the 1985 plan.

This report builds on the analyses presented in the 1985 and 1986 plans. These earlier reports and their related technical appendices provide the detailed technical information for this analysis.

METRO'S ADOPTED PLAN FOR SECONDARY TREATMENT AND CSO CONTROL

On July 29, 1986, the Metro Council adopted a plan for secondary treatment and CSO control. The CSO control plan was based on implementing CSO projects until the knee-of-the-cost/benefit-curve was achieved. For the adopted secondary plan (Core Plan 4), the knee-of-the-curve corresponded to an overall CSO volume reduction of about 61 percent. The CSO control projects at this level of control included:

- Modifications to the CATAD system to improve its efficiency.
- The Hanford separation project.
- Separation of sewers in the Diagonal, Kingdome, and Michigan Street areas.
- Separation of the Green Lake overflows and I-5 drainage from the sewers upstream of the University Regulator.

- Provisions for stormwater treatment at the existing Alki and Carkeek treatment plants.

The estimated present-worth cost of these projects phased over a 20-year period was $75.5 million in 1988 dollars.

DOE REVIEW OF METRO'S CSO PLAN AND NEW DOE CSO REGULATIONS

On Sept. 25, 1986, the state Department of Ecology advised Metro that the knee-of-the-curve level of CSO control in the adopted CSO plan was unacceptable and that a 75 percent CSO volume reduction over a 20-year period would be required. Additional correspondence with Ecology further clarified the department's concerns. In achieving a 75 percent CSO volume reduction, Metro would be required to construct facilities to control the Denny Way CSO and parallel the existing Fort Lawton tunnel within the 20-year planning period.

In addition, Ecology published a new regulation regarding CSO control on Jan. 27, 1987. This regulation contained several requirements affecting this current revision of Metro's CSO control plan:

- During earlier CSO planning, Ecology's requirement was that Metro achieve " . . . *the greatest reasonable reduction of combined sewer overflow at the earliest possible date*". The new regulation defined *"greatest reasonable reduction"* as *"control of each CSO such that an average of one untreated discharge may occur per year"*. This level of control is to be achieved at each CSO outfall. One-event-a-year represents a considerably higher level of control than even the 90 percent volume reduction considered in the 1986 CSO plan. The schedule to achieve one event a year is to be developed considering economic and environmental impacts and will be negotiated with municipalities with consideration of their individual requirements.

- Communities are to submit CSO plans complying with the new Ecology requirements by Nov. 1, 1987 for approval by Jan. 1, 1988.

- Data collected in these plans must characterize the CSO discharges and estimate historical impacts. If there are industrial or commercial sources tributary to a CSO, the sediments must be analyzed for heavy metals and organic pollutants.

- Highest priority is to be given to controlling of CSOs near water supply intakes, public primary contact recreation areas and potentially harvestable shellfish areas.

- The municipality is to propose a schedule to achieve the one-event-a-year goal. If the schedule exceeds five years, an initial five-year program is to be proposed.

PURPOSE AND SCOPE

Many of the new Ecology requirements for a CSO control plan were met in Metro's 1985 and 1986 CSO reports after careful coordination between Metro and Ecology staff. These requirements, which were presented in the earlier planning documents, include:

- Development and verification of a rainfall/stormwater-runoff CSO model (see 1985 and 1986 CSO reports and related appendices).

- Location of CSOs and establishment of baseline conditions (see Chapter 3, 1985 CSO report).

- Identification and analysis of CSO control projects (see chapters 5 and 6, 1985 CSO report and Chapter 4, 1986 CSO report). Some modifications of these projects, as well as additional projects, are described in this report.

- Estimates of CSO-related pollutant discharges (see Chapter 5 of 1986 CSO report).

This report provides the added material required by Ecology, which coupled with the earlier CSO reports will provide an overall CSO control plan meeting the new Ecology requirements. To accomplish this, the report:

- Presents information on modifications to the CSO control projects described in the earlier plans. These modifications include revised cost estimates based upon technical refinements to specific project components.

- Assesses the potential effects that the City of Seattle CSO control plan, being prepared concurrently with this report, may have on Metro CSOs and suggests approaches to perfect both programs.

- Presents a revised schedule for phasing of Metro CSO control projects to achieve the requirement of 75 percent CSO volume reduction in 20 years and identifies projects to be initiated in the next five years.

- Identifies and describes CSO control projects that could be added to the previously described projects to achieve the ultimate one CSO event a year goal systemwide.

ORGANIZATION OF REPORT

This document is organized in four chapters. To aid the reader in locating specific information, a brief description of each chapter is presented. This plan is a summary document intended to inform decision-makers and the public about the technical and economic aspects of the needed improvements. More detailed information about specific aspects of the planning work is included in previous Metro CSO reports and in a number of technical memoranda. The following chapters are included in this volume:

Chapter 1 - Introduction

This chapter presents the purpose and scope of the present effort, a brief definition of CSO and past studies and an introduction to the contents of the report.

Chapter 2 - CSO Control Projects for Core 4

This chapter describes the CSO control projects that would be used to achieve the 20-year goal of 75 percent CSO volume reduction.

Chapter 3 - Additional CSO Control Projects to Achieve One CSO Event a Year

This chapter describes CSO control projects which could be added to those described in Chapter 2 to achieve one CSO event a year.

Chapter 4 - Recommended CSO Control Program

This chapter summarizes the CSO control projects and other aspects of the recommended CSO control programs.

Appendix

Appendix A describes several items still under consideration in the secondary predesign that could affect this CSO plan. Appendix B presents phased cost tables for 75 percent volume reduction projects.

A separate volume contains several technical memoranda that present the detailed work summarized in this report.

CHAPTER 2

CHAPTER 2
CSO CONTROL PROJECTS
FOR 75 PERCENT VOLUME REDUCTION

PREVIOUSLY IDENTIFIED PROJECTS

The 1985 and 1986 Metro CSO reports defined the CSO control projects that could achieve the 20-year, 75 percent CSO volume reduction required by Ecology in a cost-effective manner. These projects are described in detail in the earlier reports and include:

- **Hanford Separation**--The stormwater separation project in the Rainier Valley would be completed by installing a new sanitary sewer inside the existing tunnel now used to convey combined flows from the valley to the Elliott Bay interceptor. Approximately 1,132 combined acres would be partially separated upstream of the tunnel.

- **CATAD Improvements**--Modifications to the CATAD control system would more fully use storage capacity in existing sewers.

- **Diagonal Total Separation**--This project would complete the total separation of sanitary and storm drainage by installing new sanitary sewers in about 720 acres of combined or partially-separated industrial area.

- **Michigan Total Separation**--This project would totally separate the sanitary and storm sewers in 1,017 acres served by combined sewers and 68 acres served by partially separated sewers.

- **Kingdome/Industrial Area Total Separation**--New sanitary sewers would be constructed to totally separate the sanitary flows from the storm runoff in about 971 industrial acres connected to combined sewers.

- **University Regulator CSO Control (Green Lake/Interstate-5 Separation)**--Storm runoff from the Densmore drain, Interstate-5 (I-5), Ravenna Park and outflow from Green Lake would be diverted from the northern interceptor system to a new storm drain.

- **Denny CSO Treatment Facility**--The substantial overflows from the Denny Way CSO regulator would be conveyed to a new CSO treatment facility for primary treatment. The treatment plant would be located on a site east of the railroad tracks about 1,000 feet from the regulator.

- **Parallel Fort Lawton Tunnel**--A parallel tunnel would allow flows to West Point to be increased from 325 million gallons a day (mgd) to 400 mgd, reducing CSO in the NSA.

- NSA **Partial Separation Projects**--14 potential partial separation projects were identified in the 1986 report that, in conjunction with other NSA CSO control projects, could achieve a 75 percent or greater reduction. For a 75 percent volume reduction in the NSA, 2,560 combined acres of mostly residential area would be partially separated using projects in nine of the 14 identified areas, removing about 630 acres of impervious area.

REVISIONS TO METRO PROJECTS

Subsequent to the 1986 CSO report, some of the projects listed above have been modified. The project modifications and the associated reasons are described below.

- **University Regulator CSO Control (Green Lake/I-5 Separation)**--In response to a Seattle Parks Department request, measures were taken during construction to avoid construction of a Ravenna Park pipeline. As a result, the cost increased from the earlier estimate of $10.5 million to $25 million.

- **Hanford Separation (Hanford/Bayview/Lander Project)**--The City of Seattle plans to reactivate the Bayview tunnel to convey and store combined sewage from a portion of the Hanford No. 1 basin. The renovated tunnel will connect to the Rainier trunk at Bayview Street at the upstream end and to the Lander trunk downstream. The project includes two new regulators. The Bayview regulator station will maximize and control storage in the Bayview tunnel. In conjunction with added storage and complete separation of 473 acres in the Lander basin, a new Lander regulator station will be built, abandoning the present regulator located on the waterfront. Additional storage and separation within the Lander basin will be achieved by a new, over-sized sanitary sewer connecting the new Bayview and Lander regulators. The existing Lander trunk will be converted to a storm drain, with an emergency overflow connection to the Lander regulator station. The city is now implementing portions of the project, including the Hanford tunnel separation, and activating the Bayview tunnel. Metro will coordinate the Bayview and Lander regulator stations and Lander separation project.

To use the Bayview tunnel only, a portion of the combined flow from the Hanford No. 1 basin will be diverted rather than all flows entering the Hanford tunnel. The total area contributing flow between the two tunnels is about 3,000 acres total. The Rainier basin upstream of the pumping station, about 2,000 acres of which will be partially separated and 1,000 acres combined is not included. The effects of splitting various proportions of the combined flow between the two tunnels has been evaluated (see Technical Memo 2.03). Little difference was found between 65/35 split between the flows through the Bayview and Lander tunnels and a 50/50 flow split. This report uses a 50/50 flow split.

This modified project is a very cost-effective method of reducing CSO in the SSA, particularly at Hanford.

- **Denny Way CSO Control**--During the review of the 1986 CSO report, concerns were expressed about the impacts of the Denny Way CSO treatment plant on the Myrtle Edwards Park. The plant would be located 1,000 feet east of the park and related CSO outfall. As part of this current plan, Metro Staff reviewed alternatives to reduce the Denny Way CSO (see Technical Memorandum 2.01).

It was found that partial separation of the Denny local area and the area directly tributary to the Lake Union tunnel would achieve an 82 percent reduction in Denny CSO volumes. Partial separation would also reduce the frequency from 51 to less than 10 events a year at a capital cost (Metro cost of $20 million) substantially less than either the Denny Way CSO treatment facility ($49 million) or total separation of the same areas ($55 million). The City of Seattle's (see page 4-3, Task 1 report, 1987 Seattle CSO plan) approach to achieving the Ecology requirement of one event a year involves to reducing inflows and *". . . vigorous enforcement of the drainage ordinance . . ."* to *". . . eventually provide control to the one CSO per year level . . ."* The volume of CSO remaining at Denny local would be 67 million gallons (MG) a year, an 82 percent reduction from existing levels. The remaining volume would gradually decrease as the drainage ordinance is enforced. As a result, partial separation of 584 acres would replace the Denny Way CSO treatment facility in this plan as a means to achieve a 75 percent volume reduction. Enforcement of the drainage ordinance would further reduce the overflows at Denny.

- **Parallel Fort Lawton Tunnel**--The Metro Council's adopted CSO plan did not include the parallel tunnel. Although the tunnel was included in the CSO projects identified for 75 percent CSO control, it was not part of the "knee-of-the-curve" projects adopted by the council. As part of the 75 percent control plan, the tunnel was scheduled to be on-line in 1997. In a July 10, 1986 letter, Ecology stated:

  > *"The parallel Ft. Lawton tunnel project is necessary to reliably achieve secondary treatment at West Point and is a cost-effective CSO project. If the Council chooses alternative 4, METRO could achieve 75 percent reduction by adding the Denny Way CSO control and Ft. Lawton tunnel projects."*

  This report considers the parallel tunnel as a project which is a basic element of the secondary plan. The cost of the tunnel capacity needed for base flows is now considered a secondary cost rather than a CSO cost. The predesign work for secondary treatment currently asumes that the tunnel will be completed by 1991.

- **Kingdome/Industrial Area Separation**--The Lander separation project, which is now an integral element of the revised Hanford/Bayview/Lander project, was previously a part of the Kingdome/Industrial area separation project. The balance of the Kingdome/Industrial area project located in the Connecticut and Hanford No. 2 basins is still referred to by the same name.

EFFECT OF REVISED PROJECTS ON CSO

Table 2-1 summarizes the effects and costs of the revised Metro CSO projects, exclusive of the effects of future city CSO projects. Technical Memorandum 2.06 presents more detailed results of the computer model evaluations of the revised CSO projects. In addition to the CSO projects shown in Table 2-1, the year 2005 base-case conditions include:

- The effects of existing and previously planned city storage projects.

TABLE 2-1

SUMMARY OF METRO CSO PROJECT EFFECTS - YEAR 2005[1]

	Annual CSO Volume Remaining (MG)	Cumulative Percent Reduction	Cumulative Cost (Millions, 1988 Dollars)	Unit Costs per MG of CSO Red.
SSA				
Existing CSO Volume	1,941	--	--	
CATAD Modifications & Hanford/Bayview/Lander[2]	994	49	18.7	$19,750
Diagonal Separation	881	55	21.6	25,700
Kingdome/Industrial Area[3]	724	63	28.9	46,500
Michigan Separation	478	75	53.2	98,900
Denny Tunnel Separation	410	79	64.6	167,600
Denny Local Separation	374	81	73.2	238,900
NSA				
Existing CSO Volume	468	--	--	
CATAD Modifications & Parallel Fort Lawton Tunnel[4]	393	16	3.7	16,700
Green Lake/I-5 Separation	240	48	28.7	163,400
Other				
Alki CSO Treatment	--	--	10.8[5]	--
Carkeek CSO Treatment	--	--	1.8[5]	--

(1) Year 2005 base case includes effects of CATAD improvements, previously planned city storage projects, the city separation of the east Lake Union area, effects of increased pumping rate from Interbay (133 mgd) and Dravus separation.

(2) Includes Lander basin portion of Kingdome/Industrial area separation project.

(3) Balance of Kingdome/Industrial area project not included in Hanford/Bayview/Lander project.

(4) Net effect of increased pumping rate from Interbay pumping station (133 mgd) is an increase in NSA CSO to 614 MG/year; parallel tunnel reduces CSO from 614 MG/year to 393 MG/year. CSO costs for parallel tunnel include only the incremental cost between base flow capacity (358 mgd) and CSO capacity (400 mgd). This incremental cost is estimated as $900,000.

(5) Capital costs for Alki and Carkeek are for each project and are not cumulative.

- Separation of the east Lake Union area which the city is currently designing.

- The addition of Alki base flows to the Elliott Bay interceptor at the Duwamish pumping station.

- Diversion of flows equal in amount to the Alki diversion from the Norfolk area to the Renton Treatment Plant.

- The affects of the increased pumping rate at Interbay (133 mgd) resulting from the secondary treatment planning.

- The city's Dravus separation project.

After the 1986 CSO control plan was issued, Ecology said that an overall CSO volume reduction of 75 percent would be acceptable and that it would not be necessary to achieve 75 percent in both the NSA and SSA. The project combination shown in Table 2-1 would reduce today's overall (NSA plus SSA) CSO volume of 2,409 MG/year to 614 MG/year, a 74.5 percent reduction. The total capital cost, including Alki and Carkeek CSO projects for a 75 percent reduction is $114.5 million. This is $67.5 million less than the total capital cost of $182 million shown in the 1986 CSO plan (Table 4-3) because of the reduced costs for Denny Way, the inclusion of the Fort Lawton parallel tunnel base flow capacity as a secondary cost, the use of a 75 percent overall CSO reduction goal rather than 75 percent in both the SSA and NSA, the use of Alki as a stormwater plant, and the added benefits from the modified Hanford project and the city's east Lake Union project.

Figure 2-1 shows the location of the projects for 75 percent CSO volume reduction. The remaining volumes of CSO at each Metro overflow point are summarized in Table 2-2. Overflow volumes are reduced at all Metro overflow locations.

The approximate frequency of overflows with the 75 percent volume reduction program described above at each Metro overflow are shown in Table 2-3. Chapter 3 discusses other projects that could be used to reduce the ultimate frequency to one event a year.

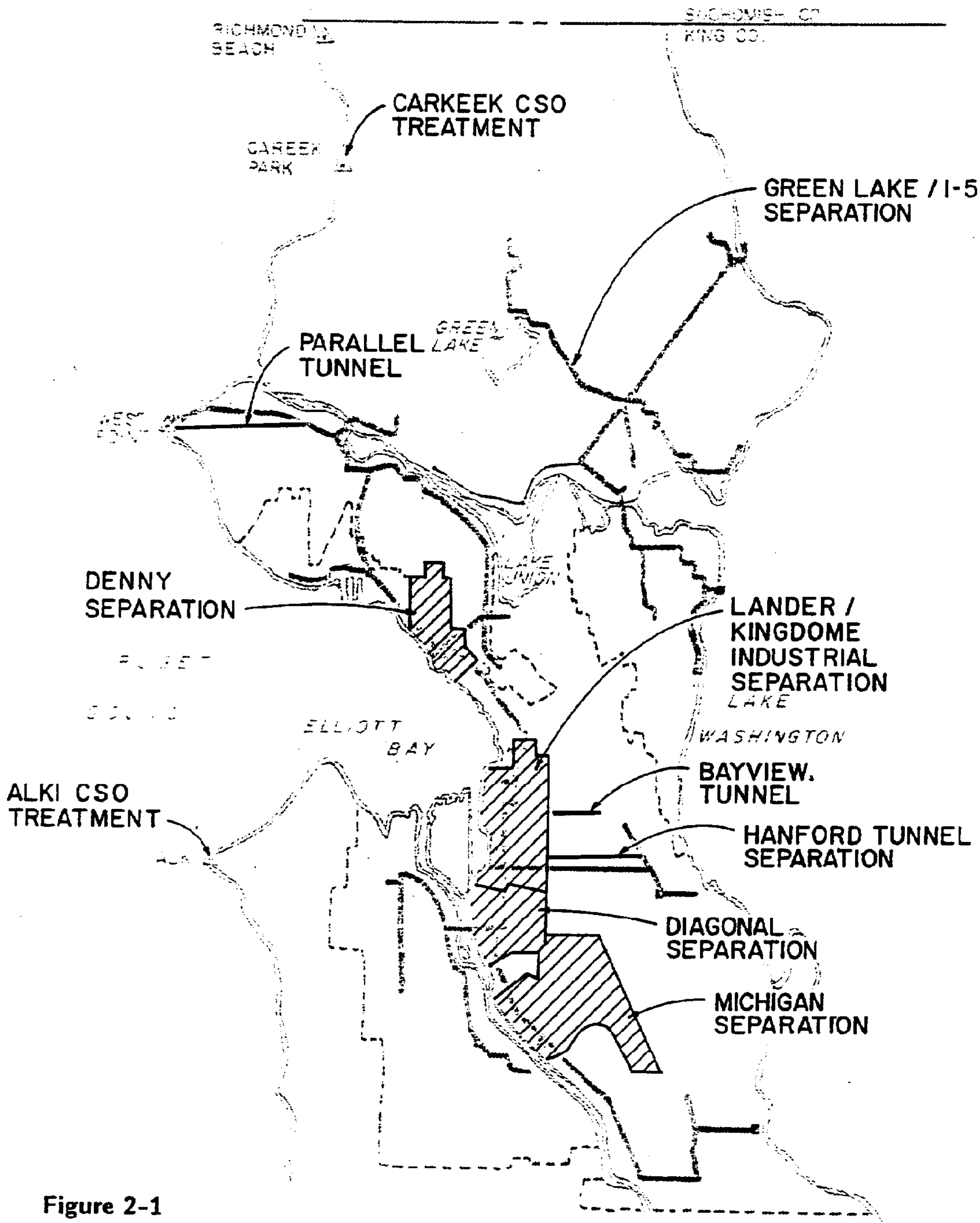


Figure 2-1

Location of CSO Projects for 75 Percent Volume Reduction

TABLE 2-2

VOLUME REMAINING AT EACH OVERFLOW 2005 (MG/YEAR)

	Existing	With 75 Percent Volume Reduction
SSA		
King	70	0.5
Norfolk	4	3
West Michigan	2	0.7
Michigan	250	4
Duwamish Pump Station	130	23
Brandon	35	10
Chelan	25	7
8th Avenue	15	11
Denny	370	42
Connecticut	90	31
Harbor	55	38
Hanford	680	99
Lander	215	105
Totals	1,941	374
NSA		
Belvoir	0	0
Canal Street	10	9
Ballard and Ballard No. 1	90	27
Dexter	12	11
University	211	96
30th North East	0	0
3rd Avenue	105	65
Montlake	40	32
Totals	468	240

TABLE 2-3

APPROXIMATE FREQUENCY OF OVERFLOWS AT 75 PERCENT OVERALL CSO VOLUME REDUCTION

Overflow Location	Approximate Frequency/Year Existing(1)	With 75 Percent Volume Reduction(2)
SSA		
King	31	1
Norfolk	7	1
West Michigan	9	1
Michigan	31	1
Duwamish Pumping Station	--	1-2
Brandon	25	1-2
Chelan	16	2-5
8th Avenue	12	2-5
Denny/Lake Union	51	5-10
Denny/Local	51	5-10
Connecticut	25	10-25
Harbor	46	10-25
Hanford	27	10-25
Lander	19	10-25
NSA		
Belvoir	0	<1
30th North East	0	<1
Canal Street	--	<1
Ballard	13	1-2
Dexter	4	1-2
University	14	5-10
Ballard No. 1	13	5-10
Third Avenue	--	5-10
Montlake	16	5-10

(1) Estimated by Metro from CATAD data--data unavailable.

(2) Frequency based upon model results using seven design storms. A range in frequency results. For example, if the model run shows that the design storm equivalent to five CSO events a year results in a spill at a given location, but that there is no spill from the ten CSO events a year storm, the projected frequency falls between five and ten events a year for that location.

PROJECT PRIORITIES

The Ecology regulations specify the criteria to be used in establishing project priorities [WAC 173-245-040,(2)(d)]:

> *"Priority ranking. Each municipality shall propose a ranking of its selected treatment/control projects. The rankings shall be developed considering the following criteria:*
>
> *(i) Highest priority shall be given to reduction of CSO's which discharge near water supply intakes, public primary contact recreation areas, and potentially harvestable shellfish areas;*
>
> *(ii) A cost-effectiveness analysis of the proposed projects. This can include a determination of the monetary cost per annual mass pollutant reduction, per annual volume reduction, and/or per annual frequency reduction achieved by each project;*
>
> *(iii) Documented, probable, and potential environmental impacts of the existing CSO discharges."*

Table 2-4 summarizes the ranking of the CSO control projects in terms of the Ecology-specified criteria.

- **CSO Near Water Supply Intake**--There are no water supply intakes near any of the CSO outfalls.

- **CSO Near Primary Contact Recreation Areas**--During the 1979 CSO planning process, high priority was given to projects that would protect the bathing beaches on Lake Washington. CSO control projects have been installed to control the one-year storm in these areas. Of the CSO projects now under consideration, the Denny Way and CATAD projects would affect overflows occurring near Myrtle Edwards park. The other CSO projects are not adjacent to primary contact recreation areas.

- **CSO Near Potentially Harvestable Shellfish Areas**--None of the CSO outfalls are near shellfish areas. The 1979 plan gave high priority to these areas (Alki and West Seattle beaches) and they have been controlled.

TABLE 2-4

PROJECT RANKING CRITERIA

	CSO Near Water Supply Intake	CSO Near Recreation Areas	CSO Near Potentially Harvestable Shellfish Areas	Previously Documented Environmental Impacts	Cost Effective-ness (Dollar per MG of Reduction)
Parallel Fort Lawton Tunnel[1]	N	N	N	Y	$4,700
Hanford/Bayview/Lander	N	N	N	Y	$19,750
Diagonal Separation	N	N	N	Y	$25,700
Kingdome/Ind. Area	N	N	N	Y	$46,500
CATAD Modifications	N	Y	N	Y	$47,000
Michigan Separation	N	N	N	Y	$98,900
Green Lake/I-5 Sep.	N	N	N	Y	$163,400
Denny Tunnel Separation	N	Y	N	Y	$167,600
Denny Local Separation	N	Y	N	Y	$238,900
NSA Sep. Projects	N	N	N	Y	$290,000

(1) Incremental CSO capacity.

- **Cost Effectiveness**--The numeric rankings in Table 2-3 are based on the cost per million gallons of CSO reduction.

- **Previously Documented Environmental Impacts**--The final environmental impact statement prepared as part of the secondary treatment facility plan addressed environmental impacts related to CSO (page 4-21):

> *"CSOs have been recognized for a number of years as a serious source of local water pollution. Early perception of CSO problems--and the priority for past CSO control efforts focused on the direct human health concerns*

associated with water contact (e.g., swimming) in an area contaminated with untreated sewage. CSOs release bacteria and potential human pathogens into receiving waters. CSO events have caused periodic closures of public swimming beaches and have contributed to decertification of areas for shellfish harvesting because of direct health hazards.

The final environmental impact statement concluded (page 4-25):

"All of the proposed CSO control projects would affect water quality at existing discharge points."

Thus, all of the CSO projects will affect areas with previously documented environmental impacts. There is no way to evaluate these impacts quantitatively because there are many other sources of pollutants affecting water quality at the same locations.

EFFECT OF METRO CSO CONTROL PROJECTS ON METRO CSO VOLUME, FREQUENCY, AND EFFECT ON PREVIOUSLY MODELED POLLUTANT LOADINGS

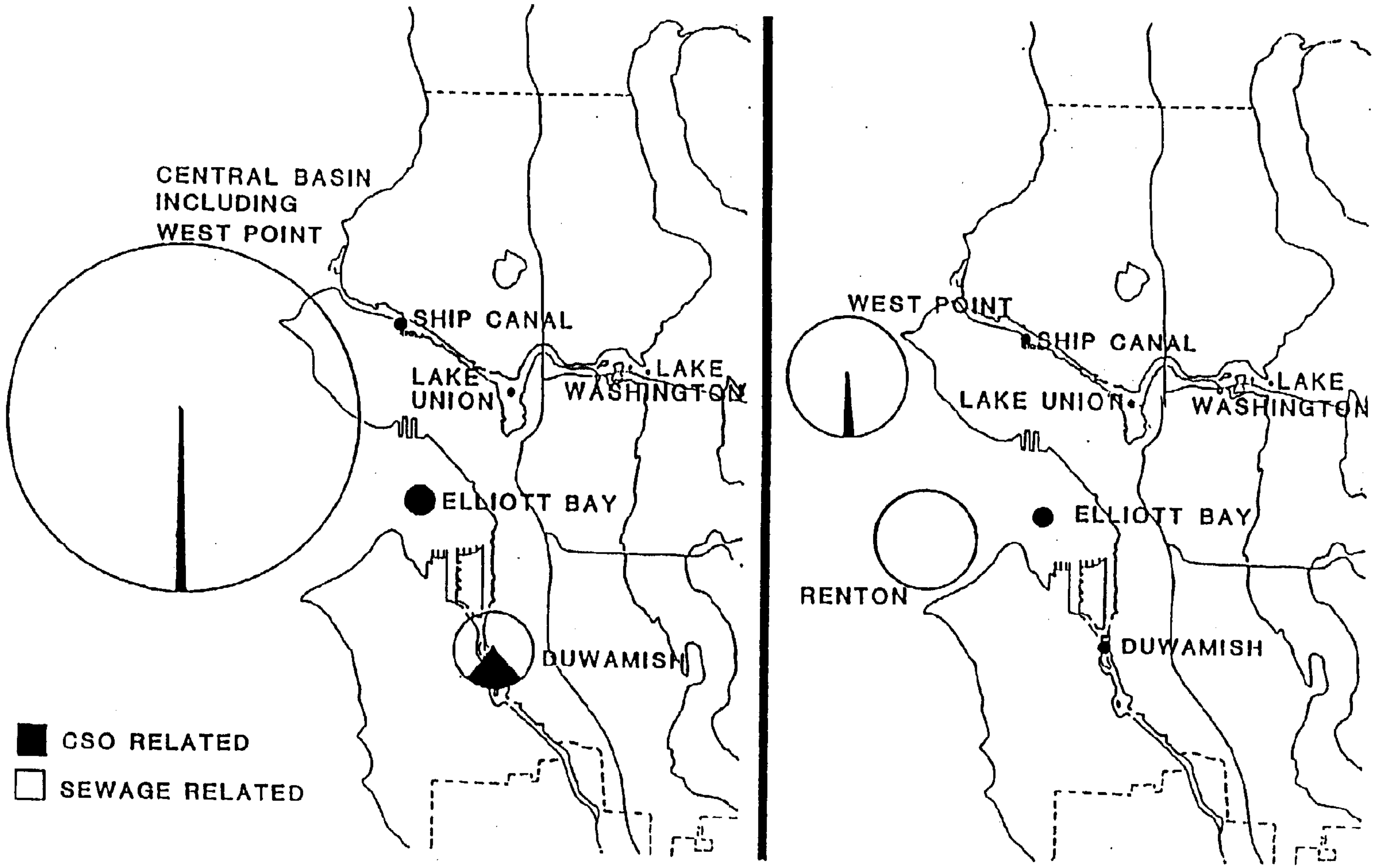
The effect of the revised Metro CSO projects has been estimated based on the previous modeling of pollutant loadings. The changes in the CSO projects are summarized below:

	For 75 Percent Volume Reduction	
	1986 Plan	1987 Plan
SSA		
CATAD	x	x
Hanford Separation	x	
Hanford/Bayview/Lander		x
Diagonal Separation	x	x
Kingdome/Industrial Area Sep.	x	x
Michigan Separation	x	x
Denny CSO Treatment	x	
Denny Separation		x
NSA		
CATAD	x	x
Parallel Fort Lawton Tunnel	x	x
Green Lake/I-5 Separation	x	x
NSA Separation	x	

Figures 2-2, 2-3 and 2-4 compare current estimated loadings for biochemical oxygen demand (BOD), suspended solids and lead with projected loadings. Table 2-5 compares the revised loadings with those in the 1986 plan and with current, estimated loadings. In the existing combined system, there is a substantial amount of stormwater that is collected and conveyed to West Point. In the SSA, about 40 percent of the storm runoff from the area served by combined sewers is collected and conveyed to West Point. When combined sewers are separated to eliminate spills of sanitary sewage, those portions of stormwater loadings that currently go to West Point will be discharged from the new separate storm drains to other receiving waters. Whenever a storm causes runoff, there will be a discharge from the new storm drain. Total separation of the sewers eliminates the spills of raw sewage and the related viruses and bacteria--an important achievement. However, the discharge of stormwater, a portion of which previously was treated at West Point, can increase the localized loadings of the contaminants found in storm runoff, specifically suspended solids and some metals. Whether or not these increases are significant depends upon the portion of the total loadings that they contribute at a given location and whether or not they cause a violation of a water quality standard. Careful evaluation of potential effects from storm drain discharges will be made during the predesign environmental process. If necessary, corrective measures will be identified and implemented on a project-specific basis. These measures could include:

- **Source Control**
  - Source tracing
  - Hazardous material storage, handling, disposal
  - Citizen and business education programs
  - Good housekeeping for business and industry
  - Implementation of regulatory agency programs
  - Vehicle emission testing

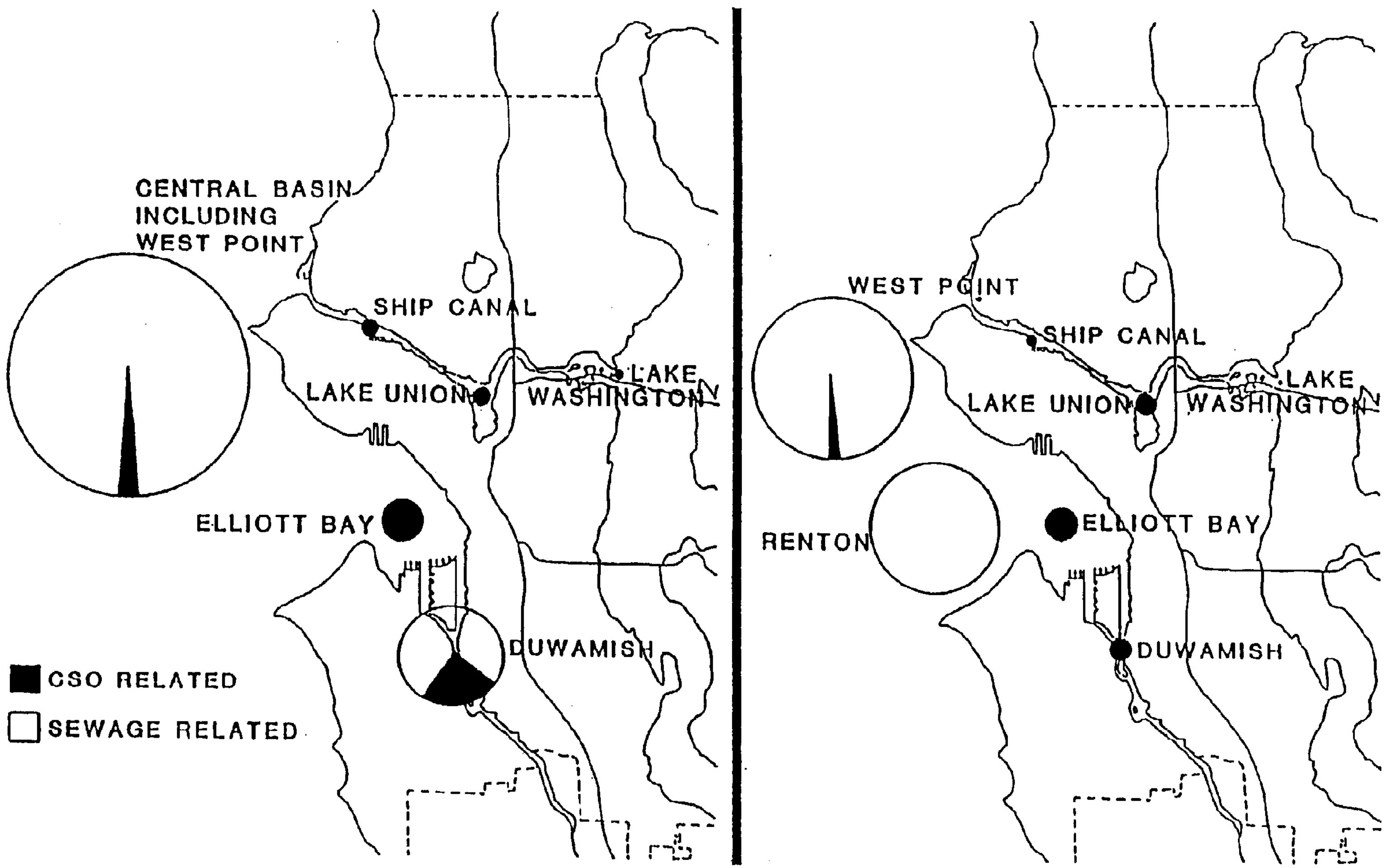
- **Best Management Practices**
  - Construction of detention facilities
  - Use of oil/water separators
  - Artificial wetlands for stormwater retention
  - Erosion and sediment control for construction
  - Improved operation and maintenance of catch basins
  - Dry well infiltration basins
  - Appropriate ordinances for new construction



CURRENT ANNUAL BOD DISCHARGES VS. YEAR 2005 COMPARATIVE CSO-RELATED BOD ANNUAL LOADINGS

Figure 2-2

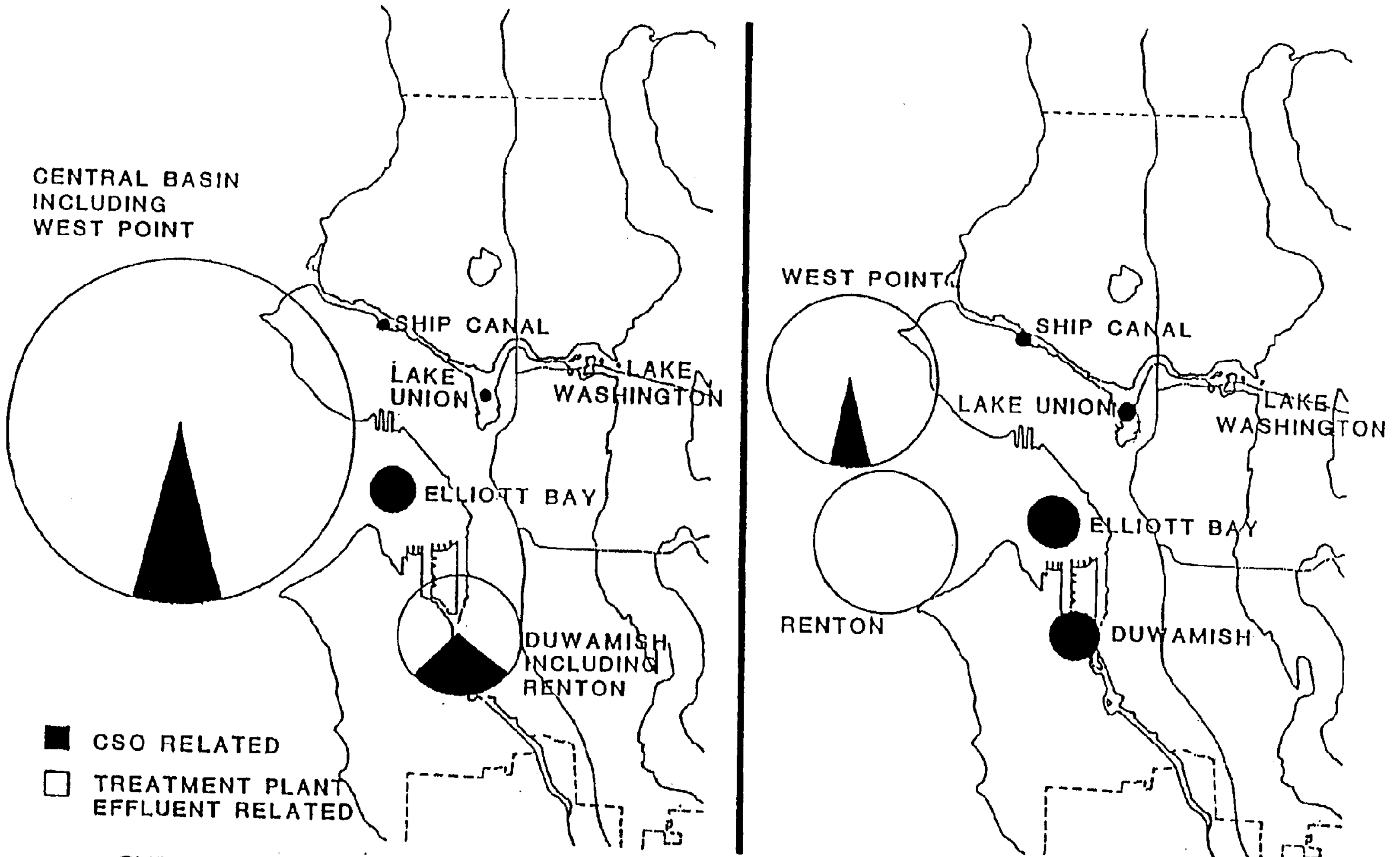
75% CSO VOLUME REDUCTION



CURRENT ANNUAL SUSPENDED SOLIDS DISCHARGES VS. YEAR 2005 COMPARATIVE CSO-RELATED SUSPENDED SOLIDS ANNUAL LOADINGS

75% CSO VOLUME REDUCTION

Figure 2-3



CURRENT ANNUAL LEAD DISCHARGES VS. YEAR 2005 COMPARATIVE CSO-RELATED LEAD ANNUAL LOADINGS

75% CSO VOLUME REDUCTION

Figure 2-4

TABLE 2-5

CSO POLLUTANT LOADINGS (POUNDS PER YEAR) AT 75 PERCENT CSO REDUCTION 1986 PLAN VS. REVISED PLAN

Receiving Water	CSO-Related Pollutant	Existing-- No CSO Control	75% Vol. Reduction, 1986 Plan	Revised 75% CSO Control Projects
Duwamish	Flow (MG)	1,406	373	301
	BOD	499,000	249,200	212,000
	SS	854,000	532,000	477,100
	Cadmium	47	26	23
	Lead	3,500	2,770	2,630
	Zinc	3,680	2,990	2,800
Elliott Bay	Flow (MG)	535	112	44
	BOD	467,000	165,900	103,000
	SS	519,000	300,100	444,800
	Cadmium	57	30	28
	Lead	1,930	2,220	2,905
	Zinc	2,230	2,405	3,100
Ship Canal/Lake Union/Portage Cut	Flow (MG)	454	97	240
	BOD	83,000	55,000	45,200
	SS	236,000	335,000	253,000
	Cadmium	7	9	7
	Lead	930	1,615	1,110
	Zinc	940	1,595	1,080
Lake Washington/Union Bay	Flow (MG)	13	2	2
	BOD	3,500	400	400
	SS	9,300	1,200	1,200
	Cadmium	0	0	0
	Lead	28	4	4
	Zinc	30	4	4
Central Basin(1)	Flow (MG)	4,200	--	--
	BOD	184,000	225,000	235,000
	SS	501,000	288,500	284,000
	Cadmium	36	27	27
	Lead	6,160	2,120	2,100
	Zinc	6,325	2,500	2,500

(1) Based on annual average flow of 240 mgd and Renton secondary effluent composition shown in TPPS in Table D-5, TPPS Report A1, annual secondary effluent loadings to central basin could be: flow=87,600 MG/year; BOD=11,000,000 lbs; SS=18,250,000 lbs; lead=32,900 lbs; cadmium=1,460 lbs; zinc=35,100 lbs. Loadings shown in this table for "No CSO Control, Existing" are those resulting from stormwater which is conveyed to West Point, treated and discharged to central basin. Future central basin loads include those from stormwater plus the CSO loads that are transferred to a secondary plant as a result of CSO projects.

(2) Flow volumes are annual volumes and are untreated CSO only. Loadings are expressed as pounds per year and include CSO-related loads discharged from outfalls from treatment facilities, loads in remaining spills of untreated CSO, and loads from separated stormwater.

As noted in the 1986 plan (page 5-4), the CSO-related pollutant loadings are a small fraction of the total suspended solids and metal loadings to Elliott Bay. The small increases in pounds per year of these pollutants discharged to Elliott Bay from those in the 1986 plan are fractions of a percent of the total input to Elliott Bay. The loadings to the Duwamish, Ship Canal/Lake Union and the central basin are either decreased or unchanged from the 1986 plan.

THE CITY'S CSO CONTROL PROJECTS

At the time of this report preparation, the City of Seattle had not completed its CSO plan. Two city projects (east Lake Union separation and Hanford/Bayview) have been incorporated in this evaluation of Metro projects. It is anticipated that other city projects will have a smaller effect on Metro than these two; however, it may be necessary to revise this plan once the complete list and timing of city projects becomes available. When the city plan is available and the Metro plan is adopted, Metro expects to work with Ecology and the city to optimize timely benefits of the CSO control programs to best achieve community objectives within the requirements of state law.

CHAPTER 3

CHAPTER 3
ADDITIONAL CSO CONTROL PROJECTS TO ACHIEVE ONE CSO EVENT A YEAR

CSO REMAINING AFTER 75 PERCENT CSO VOLUME REDUCTION PROGRAM

Tables 2-2 and 2-3 summarize the frequency and volume of remaining CSO. Although both frequency and volume are reduced substantially, the frequency exceeds one event a year at several locations.

METHOD USED TO APPROXIMATE ACHIEVING ONE EVENT A YEAR

As described in Chapter 2, SACRO model runs were made for the NSA and SSA to determine the volume of CSO remaining at each outfall with the above 75 percent CSO volume reduction package of CSO control projects for the seven design storms. The design storms were evaluated to determine which one most closely approximates the control level needed to achieve one CSO event a year (see Technical Memorandum 2.05). It was found that storm 6 was the appropriate storm. The model run outputs were evaluated to determine which outfall overflows still occur for storm 6, even after application of all previously identified CSO projects. For these outfalls, projects were identified in the tributary drainage areas that could reduce or eliminate overflows from storm 6. In this manner, an approximation of the long-term projects needed to supplement the initial CSO control projects to ultimately achieve the one event a year goal was made.

CSO CONTROL PROJECTS WHICH COULD BE ADDED TO THE 75 PERCENT CSO CONTROL PROGRAM TO ACHIEVE ONE EVENT A YEAR

Previously Identified Projects

Metro's 1985 and 1986 CSO reports identified potential projects that could be applied to achieve one CSO event per year. These are summarized below (refer to earlier reports for detailed information):

NSA Separation Projects--

The 1986 CSO control plan identified 14 separation projects in the NSA involving a total of 882 impervious acres. Of this total, 9 projects involving 632 acres were included in the 1986 plan for achieving 75 percent reduction in NSA CSO. As discussed in Chapter 2, none of these projects are included in the overall 75 percent volume reduction program.

Duwamish CSO Treatment Facility--

A CSO treatment facility would be located near the Duwamish pumping station. The treated CSO would be conveyed to Elliott Bay in the vicinity of King Street. This facility was described in the November 1985 CSO plan, and some modifications to the project were described in the July 1986 plan.

University Regulator Storage--

This project, involving 20 MG of storage in a University of Washington parking area, was described and evaluated in Volume III of the 1985 CSO control plan. If used, the location of the storage will need to be reviewed during predesign because of subsurface conditions and concerns expressed by the University about the site identified in Volume III. Alternatives to this storage project are presented later in this chapter.

Dexter Regulator Storage--

A storage site in the area draining toward the Dexter regulator station was proposed in the November 1985 CSO control plan. That storage project, however, called for transfer of stored combined sewage to the Elliott Bay interceptor by means of the Lake Union tunnel. Since the tunnel's capacity during some storms is full, a second site was identified that did not use the tunnel in the 1986 plan. The storage project would provide 2.5 MG of volume immediately adjacent to the Dexter regulator in the block bounded by Dexter Avenue North and Eighth Avenue North, and Garfield and Galer Streets. When capacity was available in the central interceptor, the stored combined sewage would be pumped back into the interceptor at an existing manhole in Garfield Street. The combination of Green Lake/I-5 separation and other NSA separation projects can achieve the one event a year level of control at Dexter without this project.

Third Avenue West Weir Storage--

As described in the 1986 CSO plan, 2.7 MG of storage would be located beneath Wallace Field in the eastern portion of the block bounded by Queen Anne Avenue, West Nickerson Street, Third Avenue West and the Lake Washington Ship Canal. The concrete storage structure would be constructed beneath the existing playing field, and the field would be restored to its present condition at the end of construction. The 2.7 MG facility would be gravity-fed from a diversion structure in the central interceptor in Nickerson Street. When capacity became available following a storm, the stored combined sewage would be pumped through a new force main to a new connection with the interceptor between the Third Avenue West weir and the junction structure joining the central and north interceptors. The previously identified NSA separation projects can, when combined with other CSO control projects, achieve one event a year at the Third Avenue weir without this project.

Ballard Regulator Storage--
As described in the 1986 CSO plan, a 2.5 MG underground structure would be located in the block bounded by Ballard Avenue North West, Shilshole Avenue North West, North West Dock Place and 17th Avenue North West. When completed, the surface could be used for parking, as a park, or a combination of both. The storage facility would be gravity-fed. When capacity was available in the trunk, the contents of the storage structure would be pumped into the trunk at a point between the regulator station and the forebay of the Ballard siphon.

Ballard No. 1 Weir Storage--
As described in the 1986 CSO plan, a storage facility would be located in the western half of the block bounded by North West Ballard Way, North West 46th Street, 11th Avenue North West, and Ninth Avenue North West. The storage facility would be gravity-fed. When capacity was available in the trunk, the contents of the storage facility would be pumped back to the Ballard trunk through a new 18-inch force main. The force main would reconnect with the trunk just downstream of the Ballard No. 1 weir.

Central Interceptor Downstream of Dexter Regulator Station--
The 4,000 feet of the central interceptor upstream of the Dexter regulator station consists of 84-, 66-, and 60-inch pipe. The first 4,000 feet of pipe downstream of the regulator consists of 48- and 54-inch pipe. The smaller downstream pipe acts as a bottleneck, causing overflows into Lake Union from the Dexter regulator at Galer Street. This project would replace the 4,000 feet of downstream pipe (48-inch and 54-inch) with 60-inch pipe (see 1986 CSO plan for details). This change would double the capacity of this portion of the central interceptor from about 36 mgd to 72 mgd.

Southwest Lake Washington Interceptor Downstream of Montlake Regulator Station--
The 3,000 feet of the Lake Washington interceptor upstream of the Montlake regulator station consists of 114-inch sewer, a double-barreled (42-inch and 108-inch) siphon and 90-inch pipe. The 1,800 feet of pipeline downstream of the Montlake regulator, to the junction with the northern interceptor, consists of a single 48-inch siphon under the Montlake cut and 1,100 feet of 48-inch pipe. The smaller downstream line acts as a bottleneck in the Lake Washington interceptor system, causing overflows from the Montlake regulator into the Montlake cut, between Union Bay and Portage Bay. This project would add a parallel 36-inch siphon under the Montlake cut and a parallel 36-inch pipeline from the end of the siphon to the junction with the northern interceptor. This change would increase the present capacity of the system to about 85 mgd. The parallel siphon and sewer would be installed next to the existing line, under the Montlake Bridge and along North East Pacific Street to the northern interceptor. This project would only add to overflows downstream along the northern interceptor. Therefore, removal of this bottleneck could only be implemented with projects that would provide capacity for the higher Lake Washington interceptor flows.

West Marginal Way Sewers--
As described in the 1985 CSO plan, the sewage from the west side of the Duwamish River is conveyed to the east side with parallel 21-inch and 42-inch siphons under the Duwamish River. The storm-generated flows from the west side of the Duwamish frequently exceed the capacity of the siphons. Added conveyance capacity from the west side to the east side would relieve the overflows on the west side, but would transfer the overflows downstream. A 48-inch sewer from Chelan to the juncture of a new 42-inch sewer from West Michigan would combine with a new 60-inch sewer to the siphon. A new 48-inch siphon is required that discharges to a new 60-inch sewer connecting to the Duwamish pumping station.

Projects Not Previously Identified

City of Seattle Drainage Ordinance--
The City of Seattle's grading and drainage ordinance No. 108080 requires that new developments greater than 2,000 square feet (a reduction to 750 square feet has been proposed) must have a drainage control plan. As new development occurs, this ordinance will reduce CSO volumes and frequency. The city estimates that by the year 2030, at current rates of construction, a majority of available acreage for development will have been constructed or reconstructed in compliance with the drainage ordinance.

Several added partial separation projects have been identified and evaluated for this report. The general location of these projects is shown in figures 3-1 and 3-2. Technical Memorandum 2.08 presents detailed information. The projects are summarized below:

In the NSA, the separation project affects are largely isolated to one CSO location which is identified. In the SSA, projects affect several locations. Basins 1 through 6 in the SSA for example, affect Harbor, Chelan, and Hanford. Thus, no specific CSO is identified for the SSA projects.

Reduce Ballard CSO (Basins 1 and 2, Figure 3-1)

Separate Greenwood/Eighth Avenue Area (Basin 1)--
The residential area north of North West 65th Street between Greenwood Avenue North and Eighth Avenue North West is served by a combined sewer system which connects into a partially separated sewer system south of North West 65th Street before connecting into the northern interceptor. This project would partially separate the stormwater runoff from the combined area (314 acres) by installing storm drains, connecting the existing catch basins or adding new catch basins and discharging directly into the Lake Washington canal.

Separate 15th Avenue/Eighth Avenue Area (Basin 2)--
The residential area north of North West 65th Street between Eighth Avenue North West and 15th Avenue North West is served by a combined sewer system that connects into a partially separated sewer system south of North West 65th Street before connecting into the northern interceptor. This project would partially separate the stormwater runoff from the combined area (380 acres) by installing storm drains, connecting the existing catch basins or adding new catch basins and discharging directly into the Salmon Bay waterway.

Reduced Ballard No. 1 CSO (Basins 3 and 4, Figure 3-1)

Separate 16th Avenue/25th Avenue Area (Basin 3)--
The residential area north of North West 65th Street between 16th Avenue North West and 25th Avenue North West is served by a combined sewer system that connects into a partially separated sewer system south of North West 65th Street before connecting into the northern interceptor. This project would partially separate the stormwater runoff from the combined area (355 acres) by installing storm drains, connecting the existing catch basins or adding new catch basins and discharging directly into the Salmon Bay waterway.

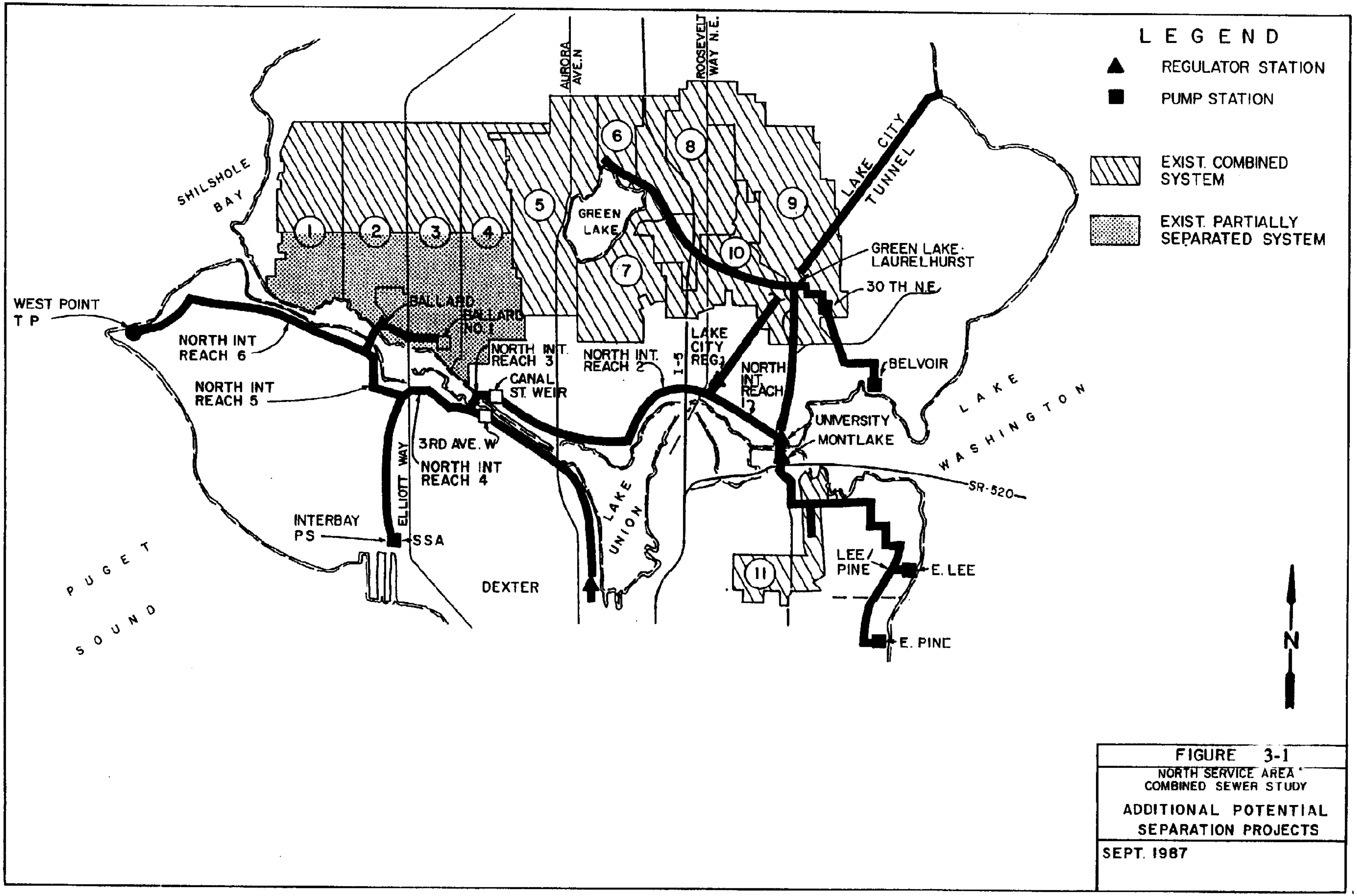


FIGURE 3-1
NORTH SERVICE AREA
COMBINED SEWER STUDY
ADDITIONAL POTENTIAL SEPARATION PROJECTS
SEPT. 1987

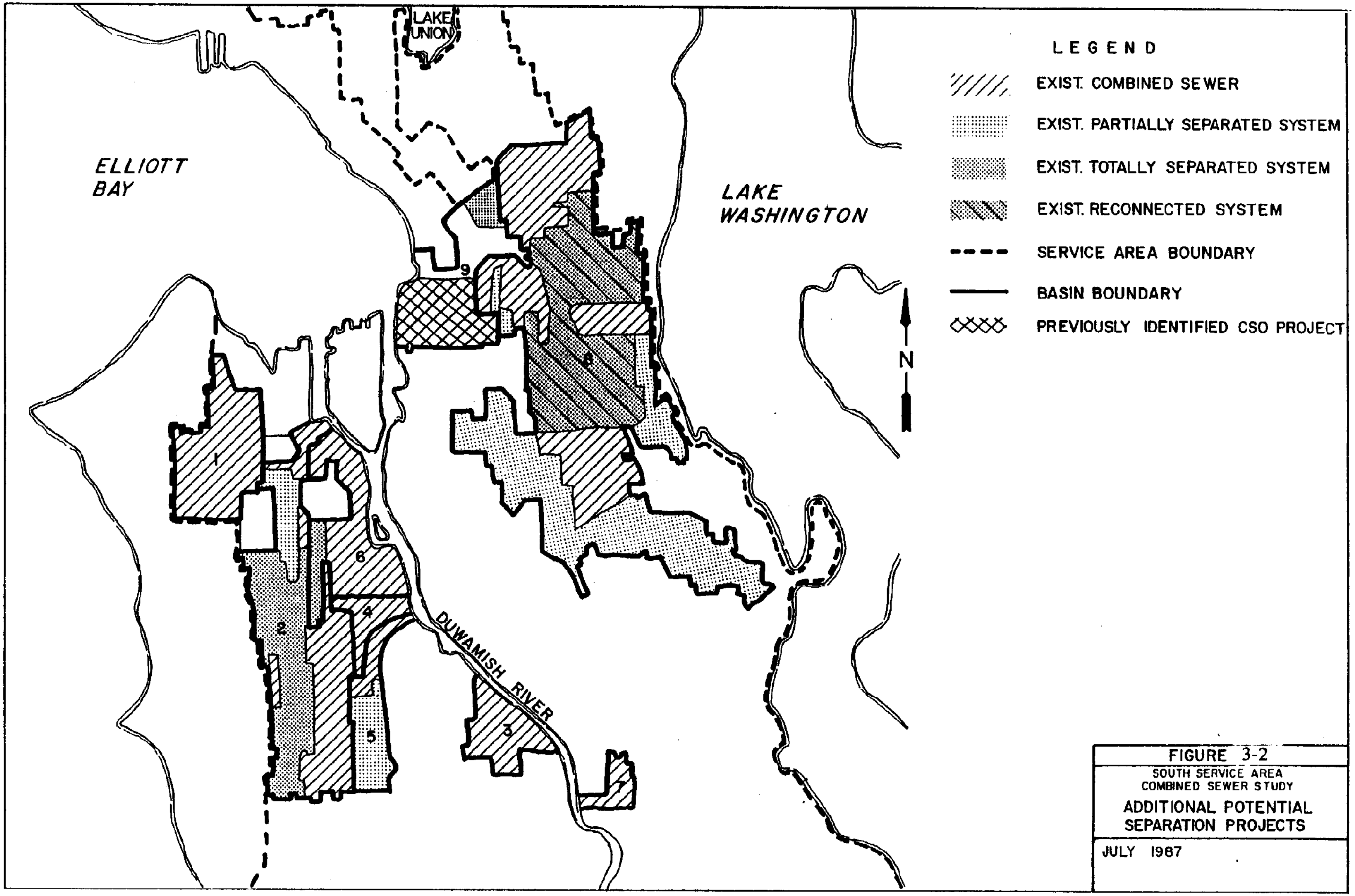


FIGURE 3-2
SOUTH SERVICE AREA
COMBINED SEWER STUDY
ADDITIONAL POTENTIAL SEPARATION PROJECTS
JULY 1987

Separate 26th Avenue/33rd Avenue Area (Basin 4)--
The residential area north of North West 65th Street between 26th Avenue North West and 33rd Avenue North West is served by a combined sewer system which connects into a partially separated sewer system south of North West 65th Street before connecting into the northern interceptor. This project would partially separate the stormwater runoff from the combined area (335 acres) by installing storm drains, connecting the existing catch basins or adding new catch basins and discharging directly into the Salmon Bay waterway.

Reduce University CSO (Basins 5 through 10, Figure 3-1)

These separation projects are an alternative to the University storage project described in the 1986 plan.

Separate West Green Lake Area (Basin 5)--
The residential area west of Green Lake is served by a combined and a totally separated sewer system that connects into the Green Lake trunk. This project would partially separate the stormwater runoff from the combined area (659 acres) by installing storm drains, connecting the existing catch basins or adding new catch basins and discharging directly into the Green Lake drainage trunk.

Separate North Green Lake Area (Basin 6)--
The residential area north of Green Lake is served by a combined and a totally separated sewer system that connects into the Green Lake trunk. This project would partially separate the stormwater runoff from the combined area (131 acres) by installing storm drains, connecting the existing catch basins or adding new catch basins and discharging directly into the Green Lake drainage trunk.

Separate Southeast Green Lake Area (Basin 7)--
The residential area southeast of Green Lake is served by a combined and a totally separated sewer system that connects into the Green Lake trunk. This project would partially separate the stormwater runoff from the combined area (539 acres) by installing storm drains, connecting the existing catch basins or adding new catch basins and discharging directly into the Green Lake drainage trunk.

Separate East Green Lake Area (Basin 8)--
The residential area east of Green Lake is served by a combined and a totally separated sewer system that connects into the Green Lake trunk. This project would partially separate the stormwater runoff from the combined area (428 acres) by installing storm drains, connecting the existing catch basins or adding new catch basins and discharging directly into the Green Lake drainage trunk.

Separate North University Area No. 1 (Basin 9)--
The residential area north of the University of Washington is served by a combined and a partially separated sewer system that connects into the Laurelhurst trunk. This project would partially separate the stormwater runoff from the combined area (796 acres) by installing storm drains, connecting the existing catch basins or adding new catch basins and discharging directly into the Green Lake drainage trunk.

Separate North University Area No. 2 (Basin 10)--
The residential area north of the University of Washington is served by a combined and a totally separated sewer system that connects into the Green Lake trunk. This project would partially separate the stormwater runoff from the combined area (423 acres) by installing storm drains, connecting the existing catch basins or adding new catch basins and discharging directly into the Green Lake drainage trunk.

Reduce Montlake CSO (Basin 11)--
The residential area in the Montlake neighborhood is served by a combined and a partially separated sewer system that connects into the Arboretum and south west Lake Washington trunk. This project would partially separate the stormwater runoff from the combined area (191 acres) by installing storm drains, connecting the existing catch basins or adding new catch basins and discharging directly into Union Bay.

Enlarge Green Lake Drainage Trunk--
Several of the above NSA separation projects would result in storm discharges to the Green Lake drainage trunk. As a result, the capacity of the trunk would have to be increased. The estimated cost is $5.3 million.

optimized. Although other combinations of the projects previously described may be later selected, these representative projects provide an indication of the potential future costs to achieve one event a year.

For its initial analysis of costs, Metro evaluated partial separation projects by modeling combinations of partial separation projects until overflows from storm 6 were eliminated. The results are shown in Table 3-1 and the project locations shown in figures 3-3 and 3-4. The costs to achieve one event per year in the NSA are larger than in the SSA. There is less volume reduction in the initial program in the NSA (48 percent) than in the SSA (82 percent). The partial separation project combination for the NSA shown in Table 3-1 resulted in model predictions of zero overflow at all Metro NSA locations for storm 6. In the SSA, the project combination shown in Table 3-1 resulted in a prediction of zero overflow at seven of the 14 Metro locations, 0.1 MG or less at four of the others (essentially zero considering the modeling accuracy), and small overflows at three: Hanford (1.52 MG), Lander (2.8 MG), Denny (1.3 MG). It is anticipated that the city drainage ordinance will reduce these three, possibly to the one event a year level. If monitoring results show that there remains more than one event a year at these locations, use of total rather than partial separation may be necessary in portions of these basins, and future costs would increase.

The approximate overall cost to achieve each level of CSO control is:

	Capital Cost (Millions, 1988 Dollars)	Reduction in CSO Volume (MG/Year)	Cost/MG of CSO Reduction
75 Percent Volume Reduction	$114.5	1,822	$ 62,800
Increase 75 Percent Reduction to One Event a Year	$175.0	~500	$350,000
TOTAL	$289.5		

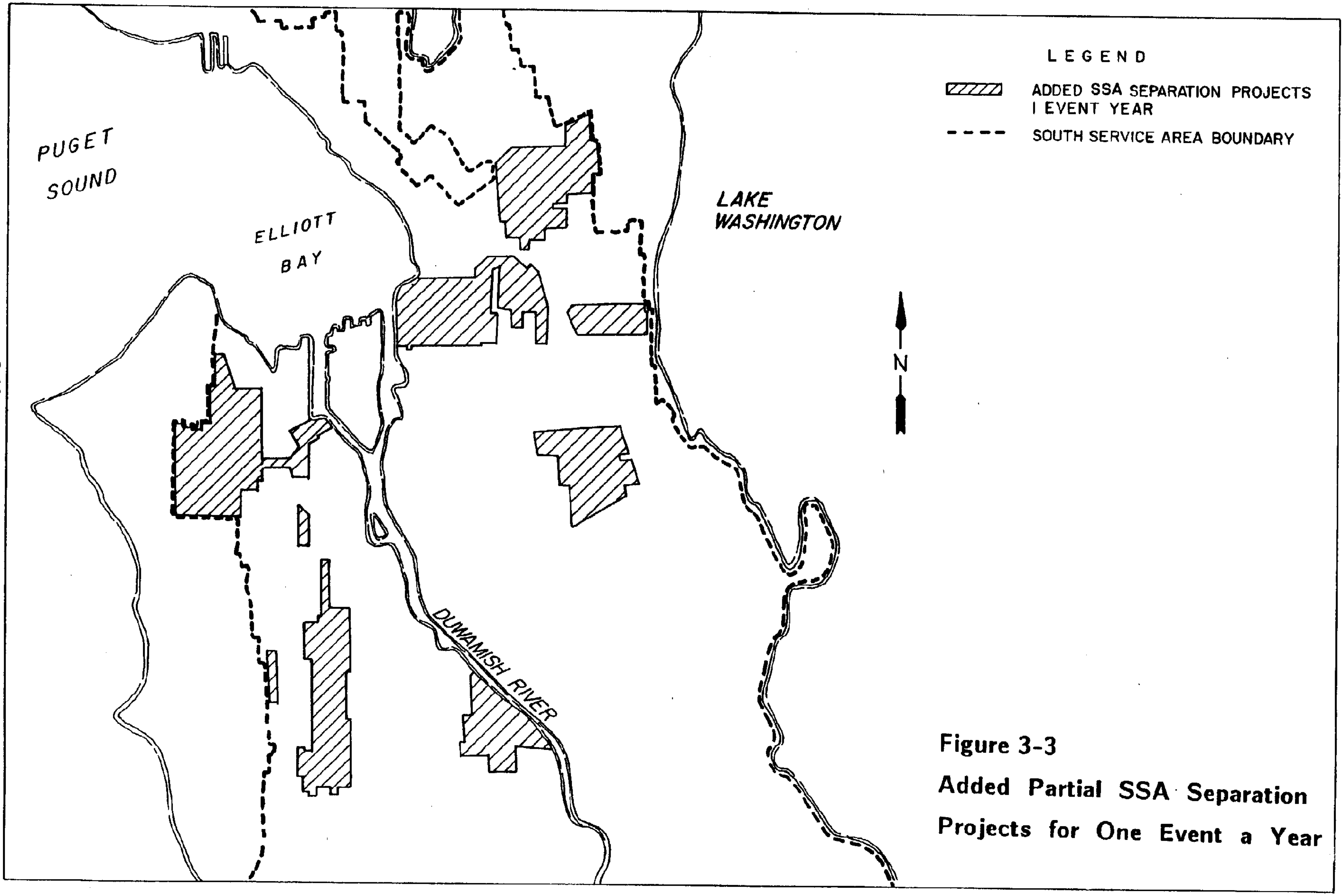


Figure 3-3
Added Partial SSA Separation Projects for One Event a Year

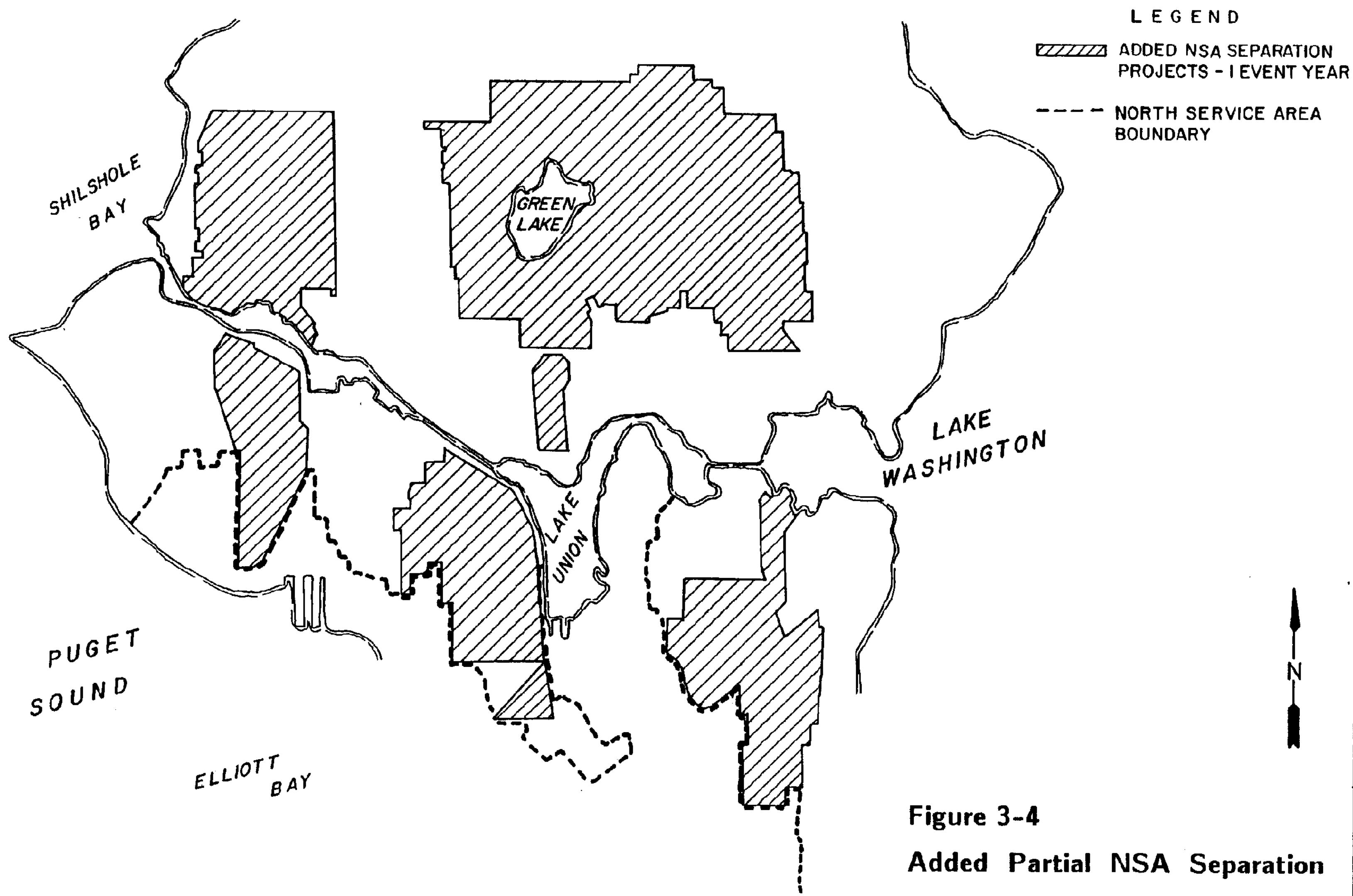


Figure 3-4
Added Partial NSA Separation Projects for One Event a Year

TABLE 3-1

PARTIAL SEPARATION PROJECTS ADDED TO 75 PERCENT CSO VOLUME REDUCTION PROGRAM TO ACHIEVE ONE EVENT A YEAR

			Capital Cost (Millions of 1988 Dollars)
NSA			
Project Area (Figure 3-1)			
1	-	Greenwood/8th Avenue	$ 5.2
2	-	15th Avenue/8th Avenue	8.4
5	-	West Green Lake	9.9
6	-	North Green Lake	1.5
7	-	Southeast Green Lake	11.4
8	-	East Green Lake	9.0
9	-	North University Area No. 1	18.6
10	-	North University Area No. 2	8.1
11	-	Montlake Area	5.6
	-	Separation Projects, 1986 Plan	42.0
	-	Enlarge Green Lake Drainage Trunk	5.3
		Subtotal, NSA	$125.0
SSA			
Project Area (Figure 3-2)			
1	-	West Harbor	$ 7.7
2	-	South Chelan	16.9
3	-	South Park	6.1
8	-	North Hanford	14.4
9	-	Connecticut	4.9
		Subtotal, SSA	$50.0
		TOTAL	$175.0

As shown by the above costs, the cost per million gallons of CSO reduction increases dramatically as the level of control increases from the 75 percent volume reduction to one event a year.

Figure 3-5 also provides a perspective on the relative cost of achieving various levels of CSO control. It is clear that costs increase dramatically; it is less certain that the benefits to the environment increase proportionately. Monitoring of the performance and impacts of the initial CSO control projects will provide data to better judge these benefits.

The representative projects used to estimate the cost of achieving one event a year involve partial separation of 2,717 acres in the SSA and 6,421 acres in the NSA. Table 3-2 and Figure 3-6 summarizes how the characteristics of the existing service area would change at 75 percent CSO volume reduction and with one event a year. In partially separated areas, about one-third of the storm runoff continues to enter the sanitary sewer system. Thus, the total equivalent acres from which runoff enters the sanitary sewer system can be summarized as follows:

	Acres From Which Runoff Enters Sanitary Sewer System		
	Existing	75 Percent Volume Reduction	One Event a Year
Combined	20,497	17,429	8,291
Partially Separated (0.33 of total area)	3,749	3,482	6,498
	24,246	20,911 (-14%)	14,789 (-39%)

Although separation plays a major role in the 75 percent control plan, runoff from 88 percent of the existing combined area will continue to enter the sanitary sewer system and receive treatment. Impacts of storm discharges from the 14 percent decrease in combined area must be carefully evaluated; however, runoff from a substantial part of the existing combined area will continue to enter the sanitary system and receive treatment. At one event per year, runoff from 63 percent of the current combined system will continue to enter the system.

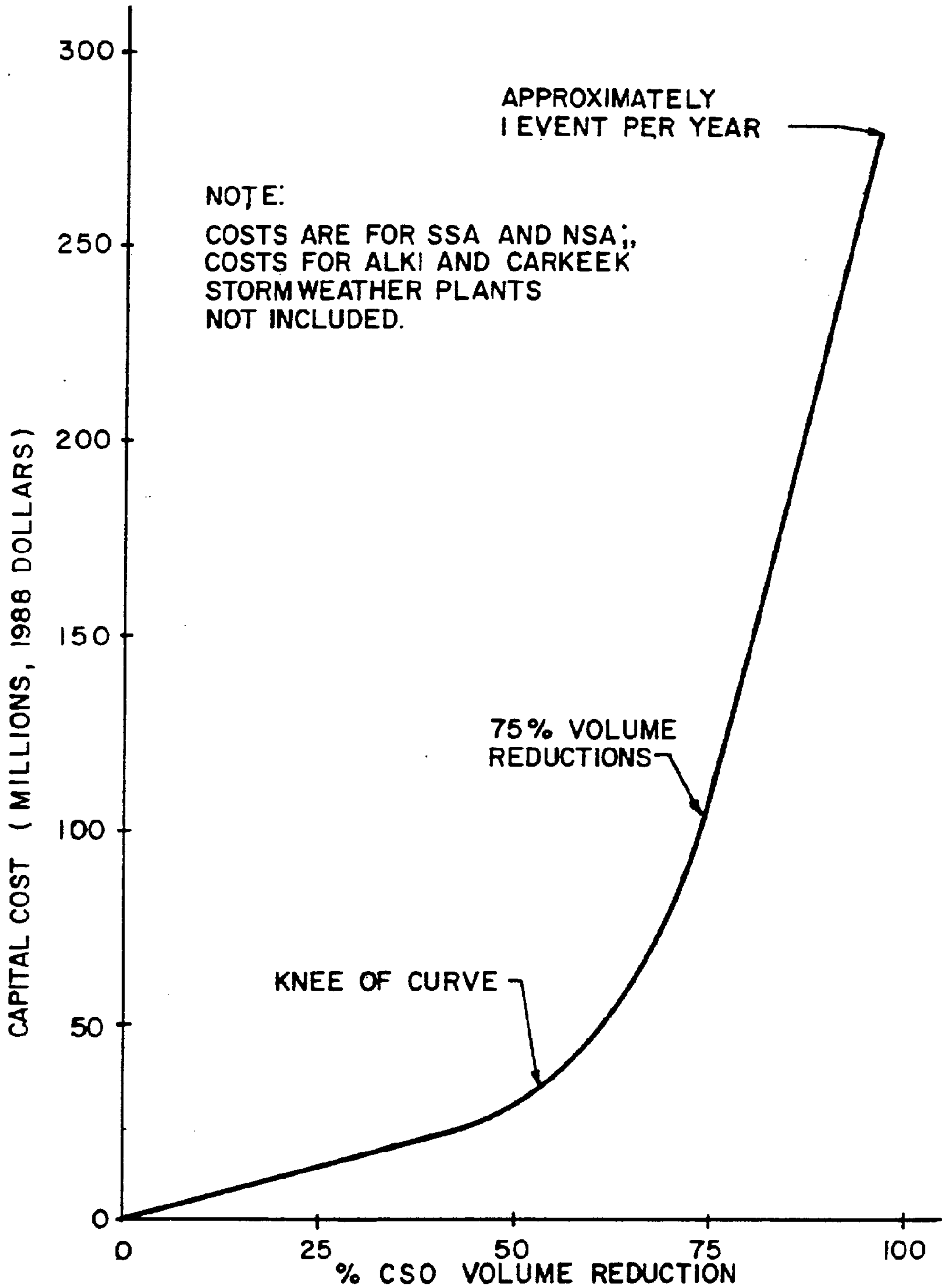


Figure 3-5

Capital Cost vs. CSO Volume Reduction

TABLE 3-2

SERVICE AREA CHARACTERISTICS

Existing Conditions, 75% CSO Volume Reduction, and One Event a Year

	Existing Area (acres)*			Area (acres) at 75% Volume Reduction**			Area (acres) at One Event/Year***		
	SSA	NSA	Total	SSA	NSA	Total	SSA	NSA	Total
Combined	8,684	11,813	20,497	5,616	11,813	17,429	2,899	5,392	8,291
Totally Separated	5,801	1,751	7,552	8,577	2,851	11,428	8,577	2,851	11,428
Partially Separated	6,550	4,811	11,361	6,842	3,711	10,553	9,559	10,132	19,691
TOTAL	21,035	18,375	39,410	21,035	18,375	39,410	21,035	18,375	39,410

* From 1986 plan Appendix, Table 1.03.1 for SSA, Table 3.01.4 for NSA.

** From individual project descriptions in 1985, 1986, and this CSO report: Lander/Kingdome separation - 971 combined acres to totally separated; Diagonal separation - 496 combined acres to totally separated; and 224 partially separated acres to totally separated; Michigan separation - 1,017 combined acres to totally separated and 68 partially separated acres to totally separated; Denny separation - 584 combined acres to partially separated; Green Lake/I-5 - 1,100 partially separated acres to totally separated.

*** From Appendix to this plan, Technical Memorandum 2.08; SSA - 2,717 combined acres to partially separated; NSA - 3,861 combined acres to partially separated, plus 9 NSA separation projects from 1986 plan where 2,560 combined acres converted to partially separated.

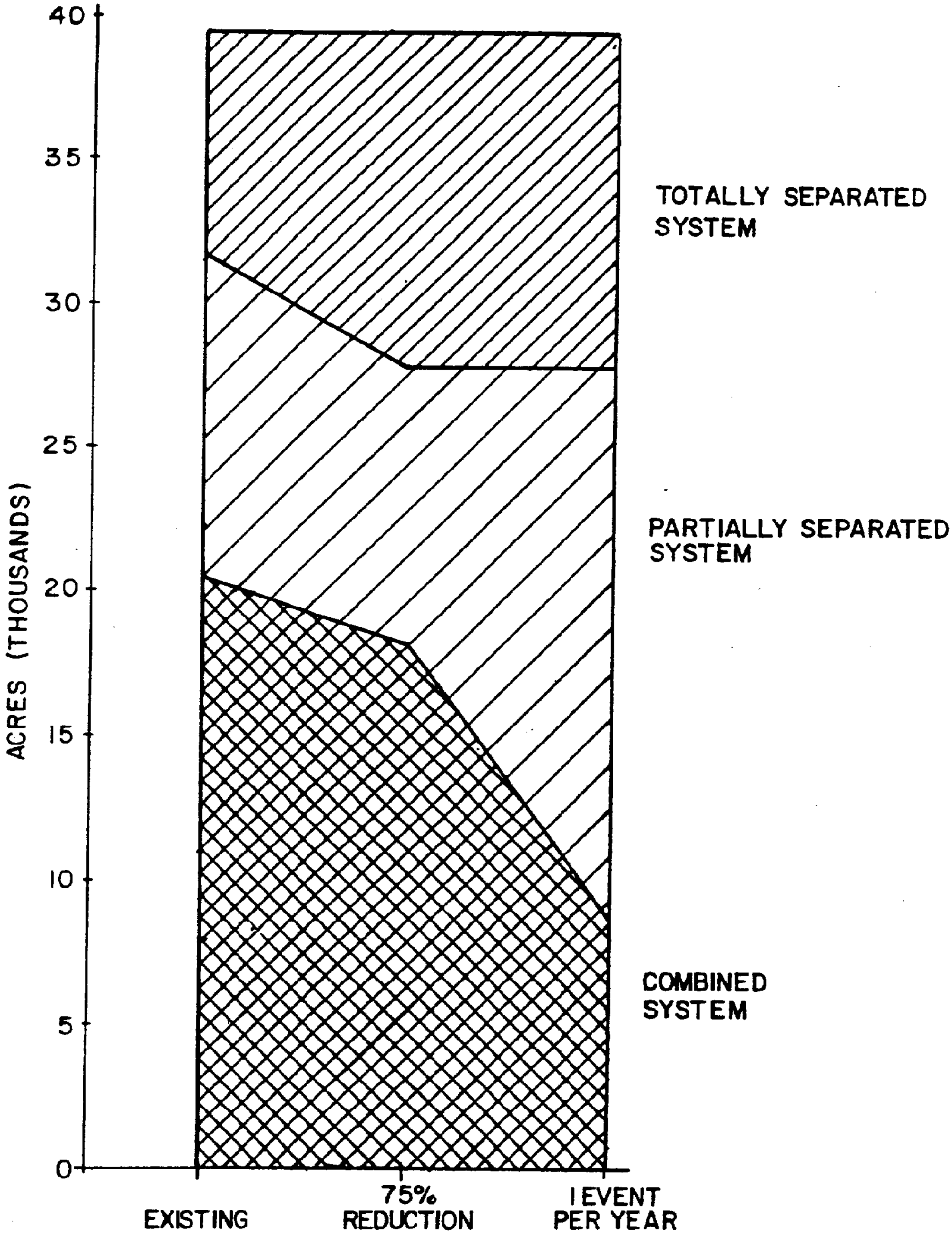


Figure 3-6

Characteristics of Service Area for Various Levels of CSO Control

CHAPTER 4

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APPENDICES

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APPENDIX A

SECONDARY PLANNING CONTINGENCIES

WHICH COULD AFFECT CSO

POTENTIAL CSO EFFECTS FROM SECONDARY PLANNING CONTINGENCIES

Off-Site Dewatering

The secondary planning team is investigating an alternative of locating sludge dewatering facilities at a site other than West Point. This alternative would involve the return of 1.1 to 2.5 mgd of sludge recycle streams at either the Duwamish pumping station or the north interceptor in the Interbay area.

The potential effects on CSO volume are as follows:

	Without Sludge Return Flow	With Sludge Return Flow Rate of[3] 1.1 mgd	With Sludge Return Flow Rate of[3] 2.5 mgd
Return of Flows to Duwamish Pumping Station			
SSA Overflow[1] (MG/Year)	994	1,010	1,030
Return of Flows to Interbay			
NSA Overflow[2] (MG/Year)	614	618	623

1 2005 base case including effects of Hanford/Bayview/Lander project, east Lake Union Separation, CATAD modifications, and increased pumping rate (133 mgd) at Interbay.

2 2005 base case including effects of Dravus separation, CATAD modifications, and increased pumping rate (133 mgd) at Interbay.

3 Constant flow rate.

In the case of the Duwamish return location, the increased overflows occur primarily at Hanford. When flows are returned in the Interbay area, the increased overflows occur at the Third Avenue weir.

The return of 1.1 mgd to the Duwamish pumping station increases SSA overflows by 16 MG/year. Using the Michigan separation project capital cost ($100,000 per MG/year reduction) as representative of the added cost to offset this effect by separation, the approximate added cost of CSO control would be $1.6 million. For return of 2.5 mgd, the added CSO cost would be $3.6 million.

The return of 1.1 mgd in the Interbay area increases NSA overflows by 4 MG/year. The NSA separation projects have a cost of about $300,000 per MG/year reduction. Thus, the added CSO cost would be about $1.2 million. Return of 2.5 mgd would increase NSA CSO costs about $2.7 million.

Increased Diversion of Flow to Renton Treatment Plant

As described in Technical Memorandum 8.01, a preliminary evaluation has been made of the approximate effects of: (1) routing some flows from the NSA to Renton in 2030 rather than diverting them back to West Point, and (2) diverting of flows from the SSA to Renton. These are alternatives are being considered in contingency planning related to secondary facilities. The conclusions (subject to the assumptions described in Technical Memorandum 8.01) are:

- Diversion of NSA flows from the separated basins of North Creek, Bear Creek and Woodinville back to West Point after 2005 would increase NSA CSO volumes by about 86 MG/year based on 2005 basin characteristics and land use. As shown on Table 2-1, the CSO reduction achieved by NSA separation projects for Core 4 cost about $300,000 per million gallons of annual CSO reduction when used in conjunction with the other Core 4 NSA CSO projects. The future diversion to West Point would require about $25.8 million in added NSA CSO control costs, based on typical separation project costs.

- The following SSA flow diversions were considered:

    - Divert 7 mgd from Norfolk, add 7 mgd from Alki at Duwamish Pumping Station
    - Divert a net of 26 mgd
    - Divert a net of 40.3 mgd

  The diversion of 7 mgd from Norfolk provides a 19 MG/year CSO reduction, which would make possible a reduction in the Michigan separation project. The entire Michigan separation project provides a CSO reduction of 241 MG/year. About 8 percent of the Michigan project could be eliminated at a CSO savings of about $1.9 million.

The diversion of 26 mgd (net) would reduce SSA CSO by 295 MG/year. This is equivalent to the entire Michigan separation project ($24.3 million) CSO reduction of 241 MG/year plus about 18 percent of the Kingdome/Industrial separation project (0.18 x $18.9 million) or a total CSO savings of about $27.8 million.

The diversion of 40.3 mgd (net) would reduce SSA CSO by 424 MG/year. This is equivalent to the entire Michigan separation project plus about 60 percent of the original Kingdome/Industrial separation project or a total CSO savings of about $36 million.

Edmonds/Richmond Beach Swap

Metro is considering an alternative that would convey Richmond Beach flows (2.4 mgd average wet weather flow, 5.4 mgd peak) to Edmonds for treatment. In exchange, the same volume of flows from the eastern portion of the Edmonds service area would be conveyed to West Point for treatment through the NSA collection system. About 35 impervious acres would require separation in the NSA to offset the increase in CSO's resulting from diversions of East Edmonds flows to West Point. The capital cost to provide the added separation is estimated to be $3.5 million. This flow exchange is now under study. These impacts will be dealt with as part of the Richmond Beach facility plan.

Kenmore Interceptor Parallel Lake Line

The existing Kenmore interceptor is nearing capacity. Increased sewage flows received at the Kenmore pumping station would be accommodated downstream by constructing a parallel Kenmore interceptor between the existing Kenmore and Matthews Park pumping stations. The construction of the North Creek/Redmond connection defers the required construction of the new lake line until after 2025.

The Kenmore parallel interceptor would have two 132-inch diameter pipes for Section 3 between the Kenmore pumping station and the proposed Logboom Park regulator. The new pipe and associated structures would provide 4.0 million gallons of off-line storage that may be used before the completion of the Section 2 lake line. As noted above, continued diversions of flows to Renton rather than West Point would eliminate the need for the Kenmore parallel line. If the parallel line is built, then Metro will consider amending this plan to optimize the amount of storage.

Rehabilitation of Brick Interceptors

Methods to rehabilitate brick interceptors in the Metro system are currently being evaluated. Some alternatives would reduce interceptor capacity and, as a result, would increase CSO volume and frequency at some locations. After the locations and methods of rehabilitation are finalized, any appropriate modifications to this CSO plan will be made.

Use of Existing Fort Lawton Tunnel

The secondary team is considering alternatives in which the new parallel Fort Lawton tunnel would be designed so that it would convey the entire 400 mgd flow rate to West Point. If Ecology would approve, the existing Fort Lawton tunnel could be abandoned as a conveyance device and converted to a storage device. Use of the existing tunnel for storage was evaluated in the 1986 CSO plan as an element in the CSO control plan for the large Duwamish alternative (see pages 2-19 and 2-23). In the large Duwamish alternative, all of the Northern Interceptor downstream of the junction with Elliott Bay Interceptor would be abandoned. In Metro's selected secondary plan, the portion which would be available for storage is dependent upon the location of the upstream end of the new tunnel alignment. This location is still under study. As noted in the 1986 plan, the cost of converting the tunnel to storage is highly dependent upon whether or not the tunnel must be lined. There are concerns that the wet-dry cycle associated with use of the tunnel for storage would cause the mortar in the brick tunnel to fail. If the tunnel is lined, the cost effectiveness was estimated at $240,000 per million gallons of CSO reduction in the 1986 plan. Without lining, the costs would decrease to about $80,000 per million gallons. The unit cost for CSO reduction will increase as the volume available for storage decreases. The above cost effectiveness was based on the entire volume downstream of the Elliott Bay Interceptor, 11.2 MG. The total cost, with lining, was about $1.90 per gallon of storage. The maximum available storage volume in the tunnel itself is about 3 mg. If the storage volume is limited to the tunnel and it is necessary to line the tunnel, then the cost would rise to $3 to $5 per gallon of storage, depending on the method of lining. At this cost, it is unlikely that tunnel storage would be cost effective.

Another aspect that would affect the use of the tunnel for storage is Ecology's position on the need for redundancy for the tunnel. If Ecology requires redundancy, the feasibility and cost of adding a structure to permit the use of the tunnel for both storage and conveyance would be addressed.

Metro's intent is to maximize the CSO benefits for the final tunnel configuration selected by the secondary team, whether it be for storage or conveyance of added flows. A determination of cost effectiveness will be made when the secondary predesign establishes the final criteria for the new tunnel. If other use of the existing tunnel proves to be more cost effective than an element of the current CSO plan, an appropriate modification of this CSO plan will be made.

Increased CSO Treatment Capacity at West Point

Previous CSO planning has limited the maximum flows to West Point, at 400 mgd. Should opportunities to divert larger peak flows to West Point become available within the constraints of the West Point site, further reductions in CSO would be possible. Should such an alternative arise during the course of secondary design, its cost effectiveness for CSO control would be considered and this plan amended, if appropriate.

APPENDIX B

PHASED COSTS FOR CSO PROJECTS
FOR 75 PERCENT VOLUME REDUCTION

PHASED COSTS 75% CSO VOLUME REDUCTION

22-Oct-

YEAR ON LINE	CAPITAL COST; INFLATION RATE 7.00% DISCOUNT RATE = 10.00%	BASE CAPITAL COST ($MILLION)	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	PRESENT WORTH TOTAL	FW TOTAL 2005	PW TOTAL 1995
1991	Hanford/Bayview/Lander	15.90	0.568	0.568	4.371	5.580	4.813																			
1991	CATAD Modifications	5.60		0.308	0.308	2.492	2.492																			
1992	Par. Ft. Lawton Tunnel/WP Add	0.90			0.106	0.169	0.524	0.101																		
1992	Carkeek CSO Treatment	1.80			0.200	0.295	0.652	0.652																		
1993	Alki CSO Treatment	10.80			1.080	1.660	2.687	2.687	2.687	3.204																
1999	Denny Separation	20.00								0.733	0.733	0.733	5.933	5.933	5.933											
1999	Diagonal Separation	2.90										0.160	0.160	1.291	1.291											
2003	Michigan Separation	24.30												0.891	0.891	0.891	7.209	7.209	7.209							
2006	Green Lake/I-5 Separation	25.00															0.917	0.917	0.917	7.417	7.417	7.417				
2006	Kingdome Separation	7.30															0.268	0.268	0.268	2.166	2.166	2.166				
	TOTAL CAPITAL COST IN 1988 DOLLARS	114.50	0.568	0.876	6.065	10.196	11.168	3.440	2.687	3.937	0.733	0.893	6.093	8.115	8.115	0.891	8.393	8.393	8.393	9.582	9.582	9.582	0.000			
	CAPITAL COST IN YEAR SHOWN		0.496	0.819	6.065	10.910	12.786	4.214	3.522	5.522	1.101	1.434	10.469	14.919	15.963	1.875	18.903	20.227	21.642	26.439	28.289	30.269	0.000			
	CUMULATIVE TOTAL (IN YEAR SHOWN)		0.496	1.315	7.380	18.290	31.076	35.290	38.812	44.334	45.435	46.869	57.337	72.256	88.22	90.09	109.00	129.22	150.87	177.30	205.59	235.86	235.86			
	PRESENT WORTH VALUE OF CAPITAL COST (1988 DOLLARS)	92.49	0.600	0.901	6.065	9.918	10.567	3.166	2.406	3.429	0.621	0.736	4.884	6.327	6.154	0.657	6.023	5.859	5.699	6.329	6.156	5.989	0.000	92.49	92.49	38.41
	CUMULATIVE PRES. WORTH		0.600	1.501	7.566	17.484	28.051	31.217	33.623	37.052	37.673	38.409	43.292	49.619	55.774	56.431	62.454	68.313	74.012	80.341	86.498	92.49	92.49			

O&M PHASED COSTS 75% CSO VOLUME REDUCTION

21-Oct-8

O & M COST: INFLATION RATE = 6.00%
DISCOUNT RATE = 10.00%

YEAR ON LINE		BASE ANNUAL O & M COST ($MILLION)	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	PRESEN WORTH TOTAL	PW TOTAL 2005	PW TOTAL 1995	PW TOTAL 2015
1991	Hanford/Bayview/Lander	0.071						0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071	0.071				
1991	CATAD Modifications	0.000																									
1992	Par. Ft. Lawton Tunnel/WP Add.	0.035							0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035				
1992	Carkeek CSO Treatment	0.086							0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086				
1993	Alki CSO Treatment	0.244								0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244	0.244				
1999	Denny Separation	0.000																									
1999	Diagonal Separation	0.000																									
2003	Michigan Separation	0.000																									
2006	Green Lake/I-5 Separation	0.002																					0.002				
2006	Kingdome Separation	0.000																									
	TOTAL O & M COST IN 1988 COLLARS	0.438	0.000	0.000	0.000	0.000	0.000	0.071	0.192	0.436	0.436	0.436	0.436	0.436	0.436	0.436	0.436	0.436	0.436	0.436	0.436	0.436	0.438				
	O & M COST IN YEAR SHOWN		0.000	0.000	0.000	0.000	0.000	0.085	0.242	0.583	0.618	0.656	0.695	0.737	0.781	0.828	0.877	0.930	0.986	1.045	1.108	1.174	1.250				
	CUMULATIVE TOTAL (IN YEAR SHOWN)		0.000	0.000	0.000	0.000	0.000	0.085	0.327	0.910	1.529	2.184	2.879	3.616	4.397	5.224	6.102	7.032	8.018	9.062	10.170	11.344	12.594				
	PRESENT WORTH VALUE OF O & M COST (1988 DOLLARS)	7.771	0.000	0.000	0.000	0.000	0.000	0.064	0.166	0.362	0.349	0.336	0.324	0.312	0.301	0.290	0.280	0.269	0.260	0.250	0.241	0.232	0.225	7.771	3.804	0.740	5.790
	CUMULATIVE PRESENT WORTH		0.000	0.000	0.000	0.000	0.000	0.064	0.229	0.591	0.940	1.277	1.601	1.913	2.215	2.505	2.784	3.054	3.313	3.563	3.804	4.037	4.261				

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EQUIPMENT REPLACEMENT PHASED COSTS 75% VOLUME REDUCTION

21-Oct-87

YEAR ON LINE	EQUIPMENT REP. INFLATION RATE= 6.00% DISCOUNT RATE = 10.00%	EQUIP. BASE COST ($1988)	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1991	Hanford/Bayview/Lander	0.000																								
1991	CATAD Modifications	0.000																								
1992	Par. Ft. Lawton Tunnel/WP Add.	0.000																								
1992	Carkeek CSO Treatment	0.196																								
1993	Alki CSO Treatment	1.188																								
1999	Denny Separation	0.000																								
1999	Diagonal Separation	0.000																								
2003	Michigan Separation	0.000																								
2006	Green Lale/1-5 Separation	0.000																								
2006	Kingdome Separation	0.000																								
	TOTAL EQ. REP. COST IN 1988 DOLLARS	1.384	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	EQ. REP. COST IN YEAR SHOWN		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	CUMULATIVE TOTAL (IN YEAR SHOWN)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	PRESENT WORTH VALUE OF EQ. REP. COST (1988 DOLLARS)	0.509	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	CUMULATIVE PRESENT WORTH		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

EQUIPMENT REPLACEMENT PHASED COSTS 75% VOLUME REDUCTION

YEAR ON LINE	EQUIPMENT REP. INFLATION RATE= 6.00% DISCOUNT RATE = 10.00%	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	PRESENT WORTH TOTAL	PW TOTAL 2005	PW TOTAL 1995	PW TOTAL 2015
1991	Hanford/Bayview/Lander																									
1991	CATAD Modifications																									
1992	Par. Ft. Lawton Tunnel/WP Add.																									
1992	Carkeek CSO Treatment			0.196																		-0.020				
1993	Alki CSO Treatment				1.188																	-0.178				
1999	Denny Separation																									
1999	Diagonal Separation																									
2003	Michigan Separation																									
2006	Green Lake/I-5 Separation																									
2006	Kingdome Separation																									
	TOTAL EQ. REP. COST IN 1988 DOLLARS	0.000	0.000	0.196	1.188	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.198				
	EQ. REP. COST IN YEAR SHOWN	0.000	0.000	0.794	5.099	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-2.286				
	CUMULATIVE TOTAL (IN YEAR SHOWN)	0.000	0.000	0.794	5.892	5.892	5.892	5.892	5.892	5.892	5.892	5.892	5.892	5.892	5.892	5.892	5.892	5.892	5.892	5.892	5.892	3.606				
	PRESENT WORTH VALUE OF EQ. REP. COST (1988 DOLLARS)	0.000	0.000	0.081	0.471	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.042	0.509	0.000	0.000	0.551
	CUMULATIVE PRESENT WORTH	0.000	0.000	0.081	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.509				

EQUIPMENT REPLACEMENT PHASED COSTS 75% VOLUME REDUCTION

EQUIPMENT REP. INFLATION RATE= 6.00%
DISCOUNT RATE = 10.00%

YEAR ON LINE		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1991	Hanford/Bayview/Lander											
1991	CATAD Modifications											
1992	Par. Ft. Lawton Tunnel/WP Add.											
1992	Carkeek CSO Treatment			0.196								
1993	Alki CSO Treatment				1.188							
1999	Denny Separation											
1999	Diagonal Separation											
2003	Michigan Separation											
2006	Green Lake/I-5 Separation											
2006	Kingdome Separation											
	TOTAL EQ. REP. COST IN 1988 DOLLARS	0.000	0.000	0.196	1.188	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	EQ. REP. COST IN YEAR SHOWN	0.000	0.000	0.794	5.099	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	CUMULATIVE TOTAL (IN YEAR SHOWN)	0.000	0.000	0.794	5.892	5.892	5.892	5.892	5.892	5.892	5.892	5.892
	PRESENT WORTH VALUE OF EQ. REP. COST (1988 DOLLARS)	0.000	0.000	0.081	0.471	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	CUMULATIVE PRESENT WORTH	0.000	0.000	0.081	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551

YEAR ON LINE		2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	PRESENT WORTH TOTAL	PW TOTAL 2005	PW TOTAL 1995	PW TOTAL 2015
1991	Hanford/Bayview/Lander														
1991	CATAD Modifications														
1992	Par. Ft. Lawton Tunnel/WP Add.														
1992	Carkeek CSO Treatment										-0.020				
1993	Alki CSO Treatment										-0.178				
1999	Denny Separation														
1999	Diagonal Separation														
2003	Michigan Separation														
2006	Green Lake/I-5 Separation														
2006	Kingdome Separation														
	TOTAL EQ. REP. COST IN 1988 DOLLARS	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.198				
	EQ. REP. COST IN YEAR SHOWN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-2.286				
	CUMULATIVE TOTAL (IN YEAR SHOWN)	5.892	5.892	5.892	5.892	5.892	5.892	5.892	5.892	5.892	3.606				
	PRESENT WORTH VALUE OF EQ. REP. COST (1988 DOLLARS)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.042	0.509	0.000	0.000	0.551
	CUMULATIVE PRESENT WORTH	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.551	0.509				